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STABILITY ANALYSIS FOR COMPARING COTTON VARIETIES (*GOSSYPIUM HIRSUTUM* L.)

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Four cotton (*Gossypium hirsutum*) varieties were compared for their stability of performance in 18 environments for seedcotton yield, percentage of ginning outturn and staple length. Regression coefficients (b), deviations from regression (S^2-d) and coefficients of variation (CV) were stability parameters considered in this investigation. Variety x environment interaction was significant which allowed further partitioning into environment linear and variety x environment linear. Environment linear and variety x environment linear were also significant, suggesting genetic differences among cultivars for their response to different environments. For yield and percentage of ginning outturn, variety CRIS-9 was stable indicating greater potential to perform better in a range of environments.

Key words: Stability parameters, Genotypes by environment interaction, Cotton.

Introduction

Cotton breeders have realized that cotton varieties respond differently in varying environments. Since new varieties require 10 - 12 years and other resources to develop, it seems worthwhile to develop cotton varieties that are adapted to a range of environments with fairly good performance in specific areas. Differential response of cotton varieties to different environments has led plant breeders to develop statistical procedures to determine their phenotypic stability.

Statistical methods are available for estimating homeostatis on newly developed crop varieties [1-4].Nine stability parameters have been proposed (Lin *et al.* [5]), but these stability statistic have been grouped into three concepts based on their commonality. Francis and Konnenberg [4] suggested that (i) a genotype is considered stable if its among environmental variance is small, [4] and (ii) a genotype is considered stable if its response to environments is parallel to the mean response of all genotypes in the trial and (iii) a genotype is considered stable if the residual mean square from the regression model on the environmental index is small [1]. Realizing the importance of environment effects on cotton varieties, this study was conducted to determine the stability in yield and fibre characteristics of cotton varieties evaluated at various locations over years.

Materials and Methods

Four cotton varieties (*Gossypium hirsutum*) were compared for stability in performance at six cotton growing districts of Sindh province. Two varieties from Sindh (CRIS-9, a newly developed variety and Rehmani) and two varieties from Punjab (NIAB-78, a variety grown on about 75% of cotton area in Sindh and AENB-1/85) were studied. The experiments were conducted in the National Coordinated Varietal Trial (NCVT) for three years from 1988 to 1990. Each year at each location, the experiment was laid-out in a randomized complete block design with four replications. Five rows each 45.0' long of each variety were included in a replication in all test locations. The standard distances between rows (12.5') and among plants (9.0") were followed. Normal inputs of fertilizer, irrigation, and plant protections were applied according to the recommendations of cotton crop.

The data were recorded for seedcotton yield (kg/ha), ginning outturn percentage and staple length (mm). Combined analysis of variance over environment and years were done to determine the significance of varieties x environment interaction before performing stability analysis [1].

After varieties x environment interaction was found significant, stability parameters were estimated, using statistical procedures described by Eberhart and Russell [1]. In their statistical model, varieties x environmental interaction was partitioned into environmental (Linear) varieties x environmental linear and a pooled deviations from regression. The genetic differences among cultivars from their regression upon the environmental indices were computed by dividing variety mean squares with variety x environment mean squares. An environmental index for each environment was determined by subtracting the grand mean (mean of all experiments) from the mean of all the varieties in each environment. The mean of individual variety was then regressed upon environmental index and the regression coefficients and the deviations mean square from the regressions slope were used as stability performance of varieties across environments. Significance of regression coefficient from unity was tested by using appropriate t test as:

$$\frac{1 - b}{\text{Standard error of b [1]}}$$

The differences among varieties in their response to varying environments were calculated as varieties x environmental (linear) mean square divided by pooled deviations mean square. Since the means of varieties at each location were used, the stability analysis did not involve degrees of freedom for replication.

Results and Discussion

Before the combined analysis of variance across years was conducted, it was considered important to perform individual year analysis varieties and varieties x environments interaction were significant for each year. Consequently an analysis of variance combined across years and environments were performed. In the combined analysis, the variety x environments interaction component mean square was significant for the three traits. This suggests that, varieties need thorough and repeated testing before they can be recommended for particular environments or set of environments. Similar results were reported by Patel *el al.* [6] and Alabi and Echekwu [7] for cotton.

The regression analysis was followed by using Eberhart and Russell's [1] model and the mean squares are presented in Table 1. We have treated environments as random samples from population of environments. In Eberhart and Russell's model, environments and variety x environment interaction degrees of freedom were partitioned into environment linear variety x environment linear and pooled deviations from environment linear. The significance of variety mean square for the three traits suggested presence of genetic differences in the performance of the varieties.

The environment linear mean square can be used to detect at least part of interaction effects which can be assigned to linear functions of environmental effects. If this attempt is successful, one can predict interaction effects to the extent of being able to state that certain genotypes will perform relatively better in highly favourable environments, while others are to be preferred to less favourable environments. In the present case, significance of environmental linear tested against pooled deviations mean squares implied the existence of genetical differences among the varieties for their regression on the environmental index. Accordingly, these mean squares for all the traits were significant suggesting differences in the regression coefficients of the characters because of the presence of non additive gene effects.

The pooled deviations tested against pooled error mean squares were not significant for any trait implying that regression lines of the varieties were not different from the unity (b = 1.0).

The differences among the varieties in their response to varying environmental indices become substantial if the ratio of variety mean squares over the variety x environment interaction is greater than the ratio of mean squares for varieties over pooled deviations. In our situation, this ratio is small for

TABLE 1. STABILITY ANALYSIS OF FOUR UPLAND COTTON VARIETIES FOR YIELD AND ITS COMPONENTS SAMPLED OVER SIX ENVIRONMENTS IN THREE YEARS (1988-1990).

Source of variation	Degree of freedom	Mean squares: Seedcotton yield (kg/ha)	Ginning outturn (%)	Staple length (mm)
Total	71	702729.5	2.36	1.38
Varieties (Var.)	3	1333302.2**	6.78**	11.50**
Environments (Env.) + Var. x Env.	68	674910.1**	2.17**	0.93**
Env. linear	1	1565255.0**	4.38**	3.10**
Var. x Env. linear	3	11762594.6**	29.28**	9.87**
Pooled deviations from Env. linear	64	141263.3	0.87	0.48
Pooled error	54	102617.4	1.50	0.63

** Significantly different at 1% probability levels.

TABLE 2. MEANS, GRAND MEANS AND STABILITY PARAMETERS OF FOUR UPLAND COTTON VARIETIES FOR YIELD AND ITS COMPONENTS OVER SIX LOCATIONS IN THREE YEARS (1988-1990).

Trait	Parameter+	CRIS-9	NIAB-78	AENB-1/85	Rehmani
Seedcotton	x	2697	2274	2039	2348
yield	b	0.738*	0.732*	0.840	0.675*
(Kg/ha)	S^2d	1933205	1984488	2228272	2894886
	CV	10.36	16.75	19.34	20.42
	$\overline{X}$	2339.5			
Ginning	X	35.13	34.75	33.58	34.23
outturn	b	0.767	0.2001**	1.889**	1.265
%	S^2d	10.268	10.510	9.482	25.355
	CV	3.34	2.52	6.38	5.67
	$\overline{X}$	34.42			
Staple	X	26.24	27.11	27.46	28.16
length	b	1.260	1.140	2.080**	0.756
(mm)	S^2d	9.049	3.521	14.389	3.539
	CV	3.58	2.51	5.16	1.84
	$\overline{X}$	27.24	–	–	–

+ x =mean; b = regression coefficient; S^2d = deviation from regression; CV = Coefficient of variability over environments; $\overline{X}$ = Grand mean.

**, * = Significant at 1 and 5% probability levels respectively. in both deviations from regression and coefficients of variation. Variety AENB-1/85 has a b value higher than unity (b=1.889), and is more responsive to more favourable environments. Conversely, the variety NIAB-78 will perform better in very poor environmental conditions as its b is significantly lower than unit regression (b = 0.200).

all the traits, suggesting the varieties fluctuated under varying environmental conditions.

The average performance of each variety over the environments together with regression coefficients, deviations from regression, and coefficients of variation for all the traits is given in Table 2. Consideration is given to those varieties that have means higher than the grand mean, regression coefficients b = 1.0, smaller deviations from regression (S^2d) and smaller coefficients of variation. For yield, variety CRIS-9 is considered desirable under varying environments because its mean performance is above the grand mean, regression coefficient less than 1.0 with minimum deviations from regression, and smaller coefficients of variation whereas variety AENB-1/85 will perform better in more favourable environments because its regression coefficient is not different from unity (b = 0.84). For percentage of ginning outturn, variety CRIS-9 was desirable for both favourable and unfavourable environments as its mean lint was higher than the grand mean, b less than 1.0, but not significantly different from the unit regression and smaller in both deviations from regression and coefficients of variation. Variety AENB-1/85 has a b value higher than unity (b = 1.889), and is more responsive to more favourable environments. Conversely, the variety NIAB-78 will perform better in very poor environmental conditions as its b is significantly lower than unit regression (b = 0.200).

The stability parameters for NIAB-78 were at desirable range for staple length as its mean is close to grand mean, regression coefficient close to unity (b = 1.140), minimum deviations from regression and comparatively small coefficients of variation. For yield and percentage of ginning outturn, variety CRIS-9 is more stable and will perform reliably better in a range of environments. However, for favourable to average environments; or say for more adaptive conditions, variety AENB-1/85 will perform better because its b is near to unity. For staple length, cultivars CRIS-9, NIAB-78 and Rehmani also are relatively stable. It should be emphasized that variety NIAB-78 is being cultivated in Sindh on about 75-80% of cotton acreage, but NIAB-78 is less adaptive to varying environments as compared with CRIS-9. This study further suggested that if NIAB-78 is to be grown in Sindh, it should be perferred in limited and favourable conditions.

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