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Evaluation of Some New Strains of *Gossypium hirsutum* L. for Yield Stability Across Environments

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ABSTRACT

Field experiments were undertaken to assess yield stability of some new upland cotton strains under different environments. Seven upland cotton strains and one check variety, CIM-496 were planted under eight environments. The pooled analysis of variance showed that both the linear and non-linear (pooled deviation) components were highly significant, indicating the presence of both predictable and un-predictable components of genotype-environment interaction. The stability parameters for the individual genotype revealed that the genotypes, SLH-279, CIM-496 (standard) and NIBGE-2 exhibited the regression closer to unity along with above average seed cotton yield, and thus may be stated as stable genotypes. Although MNH-768 produced above average seed cotton yield yet the regression coefficient for this genotype was greater than unity that indicated its lesser stability. Genotypes MNH-700 and BH-163 were below average in seed cotton yield but stable.

Key Words: Yield stability; Strains; *Gossypium hirsutum* L.

INTRODUCTION

Cotton occupies a place of pride and plays a significant role in the economic progress of Pakistan. Millions of people depend for their livelihood on cotton farming, ginning, textiles and cotton by-products. The multiplier effect of employment in this sector is enormous and is currently fuelling the economic engine of the country. Share of cotton and cotton manufactures is about 65% of the total export earnings. Therefore, cotton is known as 'white gold' of Pakistan economy. However, the cotton production in Pakistan is not stable when compared to the other major cotton growing countries of the world.

Sustainable production requires stable cultivars. Identifying stable and more adaptable strains/ genotypes is an important aspect of applied plant breeding. Stability studies in cotton is an essential part of breeding programme prior to the release of new variety, usually number of locations and years are necessary for adequate evaluation of cultivars. Several methods of estimating genotypes stability across environments are available (Finlay & Wilkinson, 1963; Eberhart & Russell, 1966; Brown *et al*., 1983; Geng *et al*., 1990). Cotton genotypes have been evaluated for stability in yield (Kumar, 1995; Baloch, 2001; Sial *et al*., 2001). Genotype × environment interaction for seed cotton yield was found to be significant in many researches (McPherson & Gwathmey, 1996; Tuteja *et al*., 1999). Following ANOVA analysis, stability analysis indicated that linearity had a considerable portion of genotype × environment interaction effects due to the high significance of the linear component of the interaction (Baloch *et al*., 1994; Sarma *et al*., 1994; Opondo & Ombakho, 1997).

The main objective of the present study was to evaluate the performance of the newly developed strains of upland cotton for stability in yield over different environments. Information gathered from this study will help in assessing the potential of newly developed strains of upland cottons for commercial cultivation.

MATERIALS AND METHODS

The present experimental material consisted of eight upland cotton genotypes, seven of which were new strains/ advanced lines; MNH-700, MNH-768, RH-510, SLH-279, BH-162, BH-163 and NIBGE-2 and one standard cultivar; CIM-496. All these genotypes were selected from DCR (Director Cotton Research) trial on the basis of two years performance.

The experiments were carried out at four different sites (Table I) for two years; 2003 and 2004, making 8 environments in all. Layout of all experiments was randomized complete block design (RCBD) with three replications. For each entry, plot size measured 27.87m^2, comprising five rows set 75 cm apart. Distance between plants within rows was 30 cm. Agronomic and cultural practices i.e., fertilizer application, weeding, irrigation and plant protection measures were adopted as and when required. Suitable insecticides/pesticides were sprayed against insect pests to prevent economic injury. Seed cotton was picked when the crop was mature and recorded as Kg/ plot and extrapolated in Kg/ hectare.

Statistical analysis. The analysis of variance was performed in a factorial arrangement after performing test of heterogeneity of variances. Statistical differences were sought at 5 and 1% levels of probability. The stability of the genotypes over environments was assessed by computing mean performance over environments (m_i), regression coefficient (b_i) and standard deviation (S^2d_i), following Eberhart and Russell's (1966). Mean seed cotton yield of the genotypes was plotted as dependent variable against regression coefficient (b_i) using MS - Power Point.

RESULTS AND DISCUSSION

Analysis of variance over environments (Table II) showed significant differences ($P < 0.01$) among the genotypes and environments for seed cotton yield, indicating the presence of variability among the genotypes as well as environments under which the experiments were conducted. The genotype × environment (G × E) interaction was further partitioned in to linear and non-linear (pooled deviation) components and mean squares for both sources were found significant ($P < 0.01$), suggesting the presence of both predictable and un-predictable components of G × E interaction. The G × E (linear) interaction revealed that there are genetic differences among genotypes for their regression on the environmental index.

Finlay and Wilkinson (1963) considered linearity of regression as a measure of stability. Eberhart and Russell (1966), however, emphasized that both linear (b_i) and non-linear components of G × E interaction should be considered in judging the phenotypic stability of a particular genotype. Further, Samuel *et al*. (1970) suggested that the linear regression could simply be regarded as a measure of response of a particular genotype that depend largely upon a number of environments whereas the deviation from regression line was considered as a measure of stability, genotype with the lowest or non-significant standard deviation being the most stable and vice versa.

The stability parameters for the eight genotypes are presented in Table III. Four genotypes, SLH-279, CIM-496 (standard), MNH-768 and NIBGE-2 (in order of merit) produced higher seed cotton yield than the grand mean of 2553.026 Kg/ ha. Mallanna *et al*. (1982) also did similar type of observation. The entries SLH-279, CIM-496 and NIBGE-2 exhibited regression coefficient close to unity (b_i = 1.03, 0.99 & 0.97) suggesting that these could successfully be used for general cultivation. The genotype MNH-768 exhibited $b_i > 1$, indicating its adequate response to better environment. Among these four genotypes, SLH-279 showed above average standard deviations while genotypes NIBGE-2, MNH-768 and CIM-496 exhibited below average standard deviations but all significantly deviated from zero, indicating that their performance can not be easily predicted when they are grown in different environments.

Genotypes MNH-700, BH-162, BH-163 and MNH-700 had regression values with varying degrees and above average standard deviations. The mean yield performance of these genotypes was lower than the grand mean, suggesting their average stability with poor adaptation to environmental fluctuations.

Table I. Sites where yield performance of 8 genotypes of cotton was tested

Sr. #	Sites	Locations	Average rainfall (mm)
1	Cotton Research Institute, Faisalabad.	Central Punjab	400
2	Cotton Research Station, Sahiwal.	Southern Punjab	177
3	Cotton Research Station, Multan.	Southern Punjab	127
4	Cotton Research Station, Vehari.	Southern Punjab	127

Table II. Mean squares obtained from the analysis of variance of eight cotton genotypes across environments for seed cotton yield

Source of Variation	D. F	Seed Cotton Yield
Genotypes (G)	7	350112.23**
Environments (E)	7	8421185.62**
G × E	49	181537.66**
Environment (Linear)	1	58944092.16**
G × E (Linear)	7	74335.368**
Pooled Deviation	48	174566.770**
MNH-700	6	58448.123**
MNH-768	6	44527.995**
RH-510	6	308244.879**
SLH-279	6	540848.248**
BH-162	6	69720.321**
BH-163	6	177907.046**
NIBGE-2	6	153477.984**
CIM-496	6	43359.562**
Pooled Error	128	922.588

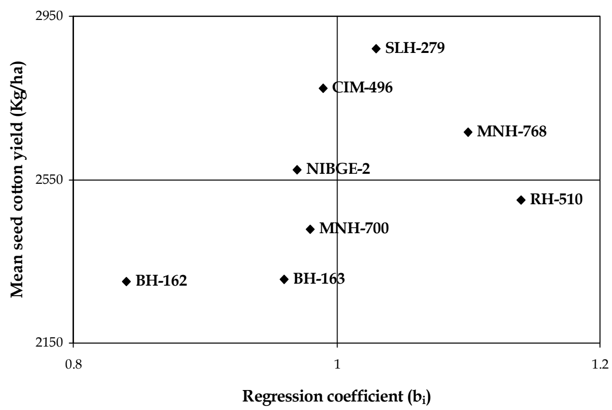
*, ** significant at 5 and 1% levels of probability, respectively

Table III. Stability parameters of 8 cotton genotypes grown in 8 environments

Genotypes	m_i	b_i	S^2d_i
MNH-700	2429.7	0.98	22899.2
MNH-768	2667.0	1.10	8979.1
RH-510	2499.1	1.14	272696.0
SLH-279	2871.5	1.03	505299.3
BH-162	2301.3	0.84	34171.4
BH-163	2306.3	0.96	142358.1
NIBGE-2	2575.0	0.97	7810.6
CIM-496	2774.5	0.99	117929.1
Average	2553.0	1.0	139017.9

Association between regression coefficient and mean seed cotton yield for individual 8 cotton genotypes is shown graphically in Fig. 1. The identification of high yielding genotypes that show high stability over environments or large response to more productive environment is of special interest. The genotypes SLH-279, CIM-496 and NIBGE-2 produced above average seed cotton yield and were stable. Although MNH-768 produced above average seed cotton yield but the regression coefficient was slightly on higher side. Genotypes MNH-700 and BH-163 were below average in seed cotton yield but stable. The genotype SLH-279 was observed stable for two stability parameters. Although deviation from regression was higher for this genotype but regression coefficient closer to unity and higher seed cotton yield from other upland cotton strains

Fig. 1. Stability diagram of 8 genotypes tested under 8 environments



and standard cultivar CIM-496, favored this in determining its stability.

REFERENCES

Baloch, M.J., 2001. Stability and adaptability analysis of some quantitative traits in upland cotton. *Pakistan J. Sci. Ind. Res.,* 44: 105–8

Baloch, M.J., B.A. Soomro, H.U. Bhutto and G.H. Tunio, 1994. Stability analysis for comparing cotton varieties (*Gossypium hirsutum* L.). *Pakistan J. Sci. Ind. Res.*, 37: 91–4

Brown, K.D., M.E. Sorells and W.R. Coffinan, 1983. A method for classification and evaluation of testing environments. *Crop Sci*., 23: 889–93

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

Finlay, K.W. and G.N. Wilkinson, 1963. The analysis of adaptation in a plant breeding programme. *Australian J. Agric. Res.,* 14: 742–54

Geng, S., H. Bingmin and M.D. Bassett, 1990. Quantification and classification of local effect on cotton cultivar programmes. *Agron. J*., 82: 514–8

Kumar, C.R.A., 1995. Identification of stable upland cotton. *Indian J. Genet. Pl. Breed.,* 55: 357–8

Mallanna, K.N., K. Mallikarjunaradhya, N.V. Channabyregowda and R. Uma Shanker, 1982. Phenotypic stability for yield in finger millet. *Indian J. Agric. Sci.,* 52: 151–2

McPherson, R. and O. Gwathmey, 1996. Yield and stability of cotton cultivars at three west Tennessee locations. *Proceedings of the Beltwide Cotton Conference*, 1: 596–8

Opondo, R.M. and G.A. Ombakho, 1997. Yield evaluation and stability analysis in newly selected 'KSA' cotton cultivars in western Kenya. *African Crop Sci. J*., 5: 119–25

Samuel, C.J.K., J. Hill, E.L. Breese and A. Davies, 1970. Assessing and predicting environmental response in *Lolium perenne*. *J. Agric. Sci. Camb.,* 75: 1–9

Sarma, R.N., A. Roy and S.K. Sarma, 1994. Phenotypic stability in upland cotton. *Ann. Agric. Res*., 15: 152–5

Sial, M.A., M.A. Arain, M.A. Javed and M.A. Rajput, 2001. Genotype-Environment interaction for grain yield in bread wheat. *Proc. Pakistan Acad. Sci.*, 38: 41–6

Tuteja, O.P., D.P. Singh and B.S. Chhabra, 1999. Genotypic × Environment interaction on yield and quality traits of asiatic cotton. *Indian J. Agric. Sci*., 69: 220–3

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