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Assessment of New Upland Cotton Genotypes (*Gossypium hirsutum* L.) for Yield Stability and Adaptability

Nasir Ghafoor Khan, Muhammad Naveed, Noor Ul Islam and Muhammad Saeed Iqbal
Cotton Research Institute, Ayub Agricultural Research Institute, Faisalabad-38950, Pakistan

Abstract: Nine promising cotton (*Gossypium hirsutum* L.) advanced lines viz., MJ-7, FH-115, VH-148, BH-162, SLH-279, CIM-534, NIAB-824, NIAB-884 and PB-899 were evaluated for their yield performance under ten contrasting environments for two years having different agro-climatic conditions in Punjab. The genotypes were evaluated for their mean yield performance and yield stability. Mean square of genotypes, environments and their interactions (G×E) were highly significant ($p<0.01$). Three genotypes out of nine i.e., PB-899, SLH-279 and VH-148 produced higher seed cotton yield than the grand mean yield. SLH-279 exhibited regression co-efficient close to unity, suggesting that it could successfully be used for general cultivation under different natural conditions. PB-899 produced highest seed cotton yield but its regression co-efficient suggests that it will perform better in less conducive environments for seed cotton yield. NIAB-884 elucidated its stability but would perform better in favorable environment for seed cotton yield. Genotypes MJ-7, BH-162, NIAB-824, FH-115 and CIM-534 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.

Key words: Yield stability, advanced lines, *Gossypium hirsutum* L.

INTRODUCTION

The phenotypic performance of a genotype is not necessarily the same under diverse agro-ecological conditions. The yield of cotton varieties shows a discrepancy due to variation in climatic and soil factors that obscures the identification of superior genotypes (Baloch *et al*., 1997). However, the genotypes those perform better than the average performance of all the genotypes over a variety of agro-climatic condition could be appraised (Mallana *et al*., 1982; Naveed *et al*., 2006). The yielding ability of genotypes is the result of its interaction with the environmental conditions (Fittouh *et al*., 1969; Rehman *et al*., 1993; Baloch, 2001; Laghari *et al*., 2003). Biologically, it occurs within the contribution (level of expression) of the genes regulating the trait differ among environments (Basford and Copper, 1998; Sial *et al*., 1999). The climatic factors such as temperature, moisture, soil fertility, day length and sowing time vary across years and locations (Bull *et al*., 1992; Sial *et al*., 2000, 2001). This requires the development of varieties with wide and specific adaptation and with high yield. G×E interaction can by far impinge on the seed cotton yield significantly (McPherson and Gwathmey, 1996; Tuteja *et al*., 1999). Following ANOVA analysis, stability analysis indicated that linearity had a considerable portion of G×E interaction effects due to the high significance of the linear component of the interaction (Baloch *et al*., 1994; Samra *et al*., 1994; Opondo and Ombakho, 1997). G×E interaction is regarded as the basic measure of stability (Eberhart and Russell, 1966; Perkins and Jinks, 1968).

The present study was carried out with the objective to identify the genotypes with high yield and stability of performance over extensive and distinct conditions.

MATERIALS AND METHODS

The experimental material comprised of nine new upland cotton strains/advanced lines; MJ-7, FH-115, VH-148, BH-162, SLH-279, CIM-534, NIAB-824, NIAB-884 and PB-899. All these genotypes were opted from DCR (Director Cotton Research) trial on the basis of two years performance. The experiments were carried out at ten different locations (Table 1) for two years; 2005 and 2006, making 20 environments in all. Layout of all experiments was Randomized Complete Block Design (RCBD) with three replications. Plot size, for each advanced line/entry, was 15×20 feet. Distance between plants within rows was 30 cm, while between

Corresponding Author: Nasir Ghafoor Khan, Cotton Research Institute, Ayub Agricultural Research Institute, Faisalabad-38950, Pakistan

Table 1: Sites where yield performance of 10 cotton genotypes was tested

Sites	Locations	Average rainfall (mm)	Temperature range (°C)	Altitude a.m.s.l.
Cotton Research Institute (CRI), Faisalabad	Central Punjab	400	4.0-48.0	185.60
Cotton Research Sub-Station (CRSS), Jhang	Central Punjab	130	1.0-48.4	148.10
Cotton Research Sub-Station (CRSS), Sargodha	Central Punjab	381	5.8-40.8	187.00
Cotton Research Station (CRS), Sahiwal	Southern Punjab	97	2.0-47.0	165.00
Cotton Research Station (CRS), Multan	Southern Punjab	127	1.0-49.0	121.90
Cotton Research Sub-Station (CRSS), Khanewal	Southern Punjab	93	1.0-48.4	128.00
Cotton Research Station (CRS), Vehari	Southern Punjab	127	1.0-48.7	135.00
Cotton Research Station (CRS), Bahawalpur	Southern Punjab	200	1.5-50.0	110.00
Cotton Research Institute (CRI), Rahim Yar Khan	Southern Punjab	165	6.8-49.7	82.93
Agronomic Research Station (ARS), Thatta Gurmani	Southern Punjab	140	1.0-48.5	122.00

Source: Pakistan Meteorological Department

rows was 75 cm. The crop was fertilized at the rate of 100-50-0 kg ha^{-1} (NPK), other agronomic and cultural practices i.e., 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 the yield was recorded as kg ha^{-1}.

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 (mi), regression coefficient (bi) and standard deviation (S^2di), following Eberhart and Russell's (1966). Mean seed cotton yield of the genotypes was plotted as dependent variable against regression coefficient (bi) using MS-Power Point.

RESULTS AND DISCUSSION

Pooled analysis of variance over locations/ environments (Table 2) exhibited significant differences ($p<0.01$) among the genotypes and environments for seed cotton yield indicating the presence of variability among the genotypes and environments under which the experiments were conducted. The linear and non-linear (pooled deviation) components of genotype and environment (G×E) interaction were separated and mean squares for both these sources were found significant, suggesting the presence of both predictable and un-predictable components of G×E interaction. Further, the linear components of G×V interaction the genetic differences among the genotypes tested for their regression on the environment index.

Different models have been proposed to evaluate the yield stability of the genotypes. Finlay and Wilksom (1963) proposed linearity of regression as a measure of stability, however, Eberhart and Russell (1966) emphasized that both linear (bi) 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 genotypes evaluated are presented in (Table 3).

In the present experimental trials, three genotypes out of nine i.e., PB-899, SLH-279 and VH-148 produced higher seed cotton yield of 2294, 2237 and 2083 kg ha^{-1},

Table 2: Pooled analysis of variance of cotton genotypes across different environments

Source of variation	df	SS	MS	F cal.
Genotypes (G)	8	4326639.198	540829.900	34.359**
Environments (E)	19	84820929.214	4464259.432	283.614**
G×E	152	28540482.368	187766.331	11.929**
Environment (Linear)	1	84820871.040	84820871.040	5388.671**
G×E (Linear)	8	1099231.474	137403.934	8.729**
Pooled deviation	162	27441309.067	169390.797	10.761**
MJ-7	18	1143020.035	63501.113	4.034**
FH-115	18	1880368.528	104464.918	6.637**
VH-148	18	3163933.693	175774.094	11.167**
BH-162	18	1531072.536	85059.585	5.404**
SLH-279	18	10402458.092	577914.338	36.715**
CIM-534	18	900758.893	50042.161	3.179**
N-824	18	1788337.412	99352.078	6.312**
N-884	18	2678637.967	148813.220	9.454**
PB-899	18	3952721.912	219595.662	13.951**
Pooled error	360	5666613.648	15740.593	

**: p<0.01

Table 3: Stability parameters of cotton genotypes across different environments

Genotypes	m_i	b_i	S^2d_i
MJ-7	1950	0.90	562173.74
FH-115	1960	1.22	88724.32
VH-148	2083	1.10	160033.50
BH-162	1798	0.84	69318.99
SLH-279	2237	0.99	47760.52
CIM-534	1887	1.09	34301.57
N-824	2012	0.89	83611.48
N-884	1899	1.02	133072.63
PB-899	2294	0.96	203855.07
Average	2013	1.00	153650.20

respectively than the ground mean yield of 2013 kg ha^{-1}. SLH-279 exhibited regression co-efficient close to unity i.e., bi = 0.99, suggesting that it could successfully be used for general cultivation, making it most stable genotype. Although VH-148 produced above average seed cotton yield, yet it exhibited regression co-efficient above unity (bi = 1.10), indicating its adequate response to better environments. Genotypes PB-899 produced the highest seed cotton yield but exhibited regression co-efficient below unity (bi = 0.96) suggesting that it will perform better in less conducive environments for seed cotton yield (Naveed *et al.*, 2006). Among these genotypes VH-148, PB-899 exhibited above average standard deviation, while SLH-279 showed below average standard deviation but all significantly deviated from zero, indicating that their performance cannot be predicted easily when they are grown in different environments.

Genotype NIAB-884 exhibited regression co-efficient close to unity (bi = 1.02) but mean yield performance of this genotype was lower than the ground mean suggesting that this genotype is stable but will perform better in conducive environment for seed cotton yield (Baloch *et al.*, 1997).

Genotypes MJ-7, BH-162, NIAB-824, FH-115 and CIM-534 had regression values with varying degrees and above average standard deviations. The mean yield performance of these genotypes was lower than the grand mean, indicating their average stability with poor adaptation to environmental fluctuations (Sial *et al.*, 2000; Laghari *et al.*, 2003).

The identification of high yielding and stable genotypes over the environments is of special interest for the researchers. A biplot showing the association between regression coefficient and mean seed cotton yield of the individual genotypes is often used for this purpose (Rehman *et al.*, 1993). Figure 1 represents the biplot showing the stability of genotypes tested across the environments. Genotype SLH-279 produced above average seed cotton yield and was stable. Although PB-899 produced the highest seed cotton yields among the genotypes tested but the egression coefficient was below unity. Genotype VH-148 also produced above average seed cotton yield but the regression coefficient was on higher side. Although genotype NIAB-884 was stable for two parameters i.e., below average standard deviation and regression coefficient close to unity yet below average seed cotton yield helped in suggesting it as average stable as it moderately adapted to environmental fluctuations.

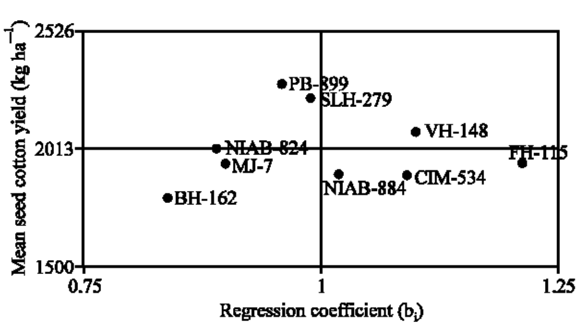

Fig. 1: Biplot showing the stability of cotton genotypes over 20 environments

CONCLUSION

Although crop management greatly sway the yield but it can be concluded that environments have their own contributions, therefore, the best performing genotypes should be tested along with the standard cultivars on farm under farmers own practices in order to assess their stability.

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