INTERNATIONAL JOURNAL OF AGRICULTURE & BIOLOGY
ISSN Print: 1560–8530; ISSN Online: 1814–9596
06-308/AWB/2008/10–1–109–111
http://www.fspublishers.org

Full Length Article

Assessment of Some Novel Upland Cotton Genotypes for Yield Constancy and Malleability

NASIR GHAFOOR KHAN, MUHAMMAD NAVEED[1] AND NOOR UL ISLAM KHAN
Cotton Research Institute, Ayub Agric. Research Institute, Jhang Road, Faisalabad-38950, Pakistan
[1]Corresponding author's e-mail: naveed1735@yahoo.com

ABSTRACT

Adaptability and stability in seed cotton yield over a wide range of environments has long been desired by plant breeders. Eight advanced lines/strains of cotton; BH-162, CIM-534, CRIS-461, FH-115, H-151-F2, MJ-7, NIAB-884 and PB-899 along with two commercial cultivars; CIM-496 and CIM-499 were tested over different environment for yield stability and adaptability. Regression of seed cotton yield on the environmental index depicted differences among the tested genotypes for yield stability and adaptability. Genotypes H-151-F2, PB-899 and CIM-496 (standard cultivar) produced the highest seed cotton yield along with the unit regression coefficient and were recognized as highly adapted to all the environments. Furthermore, genotypes CRIS-461, NIAB-884, FH-115, CIM-534, BH-162 and MJ-7 were defined as mid-adapted, while genotype CIM-499 were lowly adapted to all the environments.

Key Words: Upland cotton; Yield stability; Adaptability

INTRODUCTION

The climatic conditions of Pakistan differ from province to province and within the province as well. The cotton crop behaves differently under different environmental conditions; therefore, stability in performance is one of the most desirable characteristics of any genotype to be released for commercial cultivation. The yield of cotton is affected by the site and the season and at the same time highly significant differences in yield due to varieties and year components have been inferred (Soomro & Memon, 1979; Ahmad *et at*., 1982). The genotype × environment (G × E) interaction detects different patterns of response among the genotypes across environments. Biologically, it occurs within the contribution (level of expression) of the genes regulating the trait differ among the environments (Sial *et at*., 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*., 2001). This requires the development of having wide adaptation and high yield. Specific adaptation and high yield, G × E 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 G × E interaction effects due to the high significance of the linear component of the interaction (Sarma *et al*., 1994). G × E interaction is regarded as the basic measure of stability (Eberhart & Russell, 1966; Perkins & Jinks, 1968). The present study leads to the better understating of the stability and adaptability among cotton genotypes/advance strains over different environments.

MATERIALS AND METHODS

Plant material and experimental details. Experimental material consisted of eight new upland cotton genotypes/strains/advanced lines; BH-162, CIM-534, CRIS-461, FH-115, H-151-F2, MJ-7, NIAB-884 and PB-899 and two standard commercial cultivars, CIM-496 and CIM-499. These genotypes were selected from National Coordinated Variety Trials on the basis of two years performance. The experiments were carried out at seven different locations during the cropping season 2004-05 and 2005-06, making 14 environments in all (Table I). Layout of experiments was randomized complete block design (RCBD) with four replications. For each entry, plot (300 m^2) comprised 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 when required. Suitable insecticides/pesticides were sprayed to prevent economic losses. Seed cotton was picked when the crop was mature.

Statistical analysis. Factorial analysis of variance was performed in a factorial arrangement after conducting test of heterogeneity of variances at 5 and 1% levels of probability. Stability of the genotypes over environments was assessed by computing mean performance over environments (m_i),

To cite this paper: Khan, N.G., M. Naveed and N.I. Khan, 2008. Assessment of some novel upland cotton genotypes for yield constancy and malleability. *Int. J. Agri. Biol.*, 10: 109–111

Table I. Sites where yield performance of 18 cotton genotypes tested across different environments

#	Sites	Locations	Average rainfall (mm)	Temperature range (°C)
1	Cotton Research Institute (CRI), Faisalabad.	Central Punjab	400	4.0 – 48.0
2	Cotton Research Station (CRS), Sahiwal.	Southern Punjab	177	2.0 – 47.0
3	Cotton Research Sub-Station (CRSS), Jhang.	Central Punjab	93	1.0 – 48.4
4	Cotton Research Station (CRS), Multan.	Southern Punjab	127	1.0 – 49.0
5	Cotton Research Station (CRS), Vehari.	Southern Punjab	127	1.0 - 48.7
6	Cotton Research Station (CRS), Bahawalpur.	Southern Punjab	250	1.5 – 50.0
7	Cotton Research Institute (CRI), Rahim yar khan.	Southern Punjab	165	6.8 - 49.7

Source: Pakistan Meteorological Department

regression coefficient (b_i) and standard deviation (S^2d_i), (Eberhart & Russell 1966). Furthermore, coefficient of variation (CV) and coefficient of determination (R^2) were calculated (Francis and Kannenberg (1978) and Bilbro and Ray (1976) methods, respectively. In addition, mean seed cotton yield of the genotypes was plotted as dependent variable against regression coefficient.

RESULTS AND DISCUSSION

The mean squares of the genotypes, environments and genotype × environment (G × E) interaction were significant ($P < 0.01$) (Table II). The extent of such performance testing depended on the magnitude of genotype × environment interaction, which occurs when genotypes differ in their relative performance across environments (Bernardo, 2002). Following the genotype × environment interaction, Eberhart and Russell (1966) stability analysis was performed (Table III). Pooled analysis of variance also exhibited significant differences ($P < 0.01$) among the genotypes, environments and genotype × environment for seed cotton yield (Table III), revealing the presence of variability among genotypes as well as environments under which the experiments were conducted. The genotype × environment interaction was further partitioned into linear and non-linear components and mean squares for both sources were significant ($P < 0.01$). This suggested the presence of both predictable and un-predictable components of genotype × environment interaction. The G × E (linear) interaction indicated the presence of genetic differences among genotypes for their regression on the environmental index.

Yield performance of the genotypes. Mean seed cotton yield of the genotypes varied between 1907 (CIM-499) to 2896 kg ha^{-1} (H-151-F2). Genotypes H-151-F2 and PB-899 had higher seed cotton yield than the standard cultivars (CIM-496 & CIM-499). However, genotypes CRIS-461, NIAB-884, FH-115, CIM-534, BH-162 and MJ-7 produced seed cotton yield greater than one of the standard cultivar, CIM-499 but lower than CIM-496; the other standard cultivar (Table IV).

Stability of the genotypes. Eberhart and Russell (1966) proposed that an ideal genotype is one, which has the highest yield (m_i) over broad range of environments, a regression coefficient (b_i) value of one and deviation mean square (S^2d_i) close to zero or zero. In the present study, genotypes CIM-496, PB-899, NIAB-884, CIM-534 and H-151-F2 had regression coefficient (b_i) values of one or close

Table I1. Results of variance analysis of 10 cotton genotypes tested across different environments

Source	d.f.	Mean Squares	Significance
Genotypes	9	4125137.265	**
Environments	13	23326560.337	**
Genotype × Environment	117	401021.199	**
Error	420	88120.363	

Coefficient of Variation: 14.77% LSD at 0.05 alpha level = 489.6

Table III. Results of stability variance analysis of 10 cotton genotypes tested across different environments

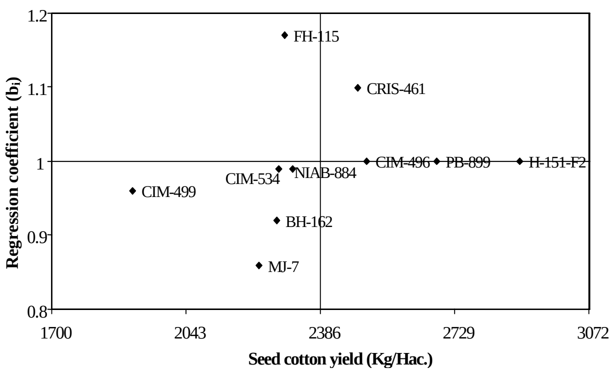
Source	d.f.	Mean Squares	Significance
Total	139	696566.5469	
Genotypes	9	1031284.316	**
Env. + (Genotypes × Environment)	130	673393.778	**
Environment (Linear)	1	75811314.095	**
Genotype × Environment (Linear)	9	45610.560	*
Pooled Deviation	120	94328.186	**
BH-162	12	90423.697	**
CIM-534	12	42591.564	*
CRIS-461	12	150356.937	**
FH-115	12	77591.632	**
H-151-F2	12	139800.884	**
MJ-7	12	62833.841	**
NIAB-884	12	84098.271	**
PB-899	12	81608.671	**
CIM-496	12	48216.436	*
CIM-499	12	165759.932	**
Pooled Error	420	22030.091	

Coefficient of Variation= 13.27% LSD at 0.05 alpha level = 237.023

Table IV. Seed cotton yield (kg ha^{-1}) and different stability parameters of 10 cotton genotypes tested across different environments

Genotype	SCY (m_i)	b_i	Sd_i^2	CV %	R^2 (%)
BH-162	2275	0.92	59360	14.38	85
CIM-534	2279	0.99	11528	13.94	90
CRIS-461	2482	1.10	119293	13.71	82
FH-115	2296	1.17	46528	13.82	81
H-151-F2	2896	1.00	31770	9.45	94
MJ-7	2229	0.86	108737	13.94	80
NIAB-884	2315	0.99	53035	13.81	88
PB-899	2684	1.00	50545	9.58	92
CIM-496	2503	1.00	17153	12.50	93
CIM-499	1907	0.96	134696	16.90	78
Average	***2387***	***1.00***	***63264***	***13.20***	***86***

Fig. 1. Seed cotton yields and Regression coefficients of 10 cotton genotypes tested across different environments



to one (Table IV). Although genotypes CIM-534 and NIAB-884 exhibited regression coefficient value close to one but their seed cotton yield was below average. Further, none of the genotype attained deviation mean square (S^2d_i) close to zero. However, mean value could be used in judging the genotypes response as this technique had been exploited earlier (Naveed *et al*., 2006). Genotype CIM-534, CIM-496, H-151-F2, FH-115, PB-899, NIAB-884 and BH-162 exhibited below average deviation mean square (S^2d_i), while genotypes MJ-7, CRIS-461 and CIM-499 exhibited above average standard deviation mean squares (S^2d_i).

Francis and Kannenberg (1978) suggested that low coefficient of variation (CV) values are the characteristics of a stable variety. In addition, Bilbro and Ray (1976) suggested that coefficients of determination (R^2) could be useful in measuring dispersion around the regression line and therefore related to the predictability and repeatability of the performance within environments. Genotypes H-151-F2, PB-899 and CIM-496 had lowest and below average coefficient of variation values, while other genotypes exhibited above average coefficient of variation values. R^2 values for H-151-F2, CIM-496 and PB-899 were 94%, 93% & 92% (Table IV), respectively indicating the reliability of the linear response of these genotypes.

Biplot analysis. Relationship between the regression coefficients (b_i) and mean seed cotton yields (m_i) for 10 cotton genotypes showed that genotypes H-151-F2, PB-899 and CIM-496 produced the highest seed cotton yield along with the unit regression coefficient (b_i) (Fig. 1). These three genotypes therefore were the group of the best adaptation to all the environments and could be recommended for cultivation. Other genotypes (CRIS-461, NIAB-884, FH-115, CIM-534, BH-162 & MJ-7) were evaluated as mid-adapted, while genotype CIM-499 was lowly adapted to all the environments.

CONCLUSION

Two new genotypes, H-151-F2 and PB-899 along with the standard commercial cultivar; CIM-496 were found to be stable. Efforts may be directed towards the further evaluation of these two new genotypes at farmer's field to gain extra confidence in releasing these strains as commercial upland cotton varieties.

REFERENCES

Ahmad, M., A.H. Memon and A.H. Baloch, 1982. Effect of site and season on varietal performance in Desi Cotton. *Pakistan Cotton*, 26: 33–5

Bernardo, R., 2002. *Breeding for Quantitative Traits in Plants*, p: 141. Stemma Press, Woodburg

Bilbro, J.D. and L.L. Ray, 1976. Environmental stability and adaptation of several cotton cultivars. *Crop Sci*., 16: 821–4

Bull, J.K., M. Copper, I.H. Delacy, K.E. Basford and D.R. Woodruff, 1992. Utility of repeated checks for hierarchical classification of data from plant breeding trails. *Field Crops Res*., 30: 79–95

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

Francis, T.R. and L.W. Kannenberg, 1978. Yield stability studies in short-season maize: I. A descriptive method for grouping genotypes. *Canadian J. Plant Sci*., 58: 1029–34

Mcpherson, R. and O. Gwathmey, 1996. Yield and stability of cotton cultivars at three west Tennessee locations. *Proceed. Beltwide Cotton Conf*., 1: 596–8

Naveed, M., N. Mukhtar, J. Farooq, M. Ilyas and N. Ul Islam, 2006. Evaluation of some new strains of *Gossypium hirsutum* L. for yield stability across environments. *J. Agric. Soc. Sci*., 2: 17–9

Perkins, J.M. and J.L. Jinks, 1968. Environmental and genotype environmental components of variability. *Heredity*, 23: 339–59

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

Sial, M.A., K.D. Jamali, M.A. Arain and M. Ahmed, 1999. Adaptability of semi-dwarf spring wheat in sindh province. *Pakistan J. Sci. Ind. Res*., 42: 342–4

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

Soomro, B.A. and A.M. Memon, 1979. Stability response analysis of arboreum cotton varieties with respect to four quantitative characters. *Pakistan Cotton*, 30: 31–8

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

(Received 06 February 2007; Accepted 15 March 2007)