Research Article

Assessment of Stability for Seed Cotton Yield of Cotton Genotypes Across Different Environmental Conditions of Sindh Province

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Abstract | Trials were carried out to evaluate seed cotton yield stability of cotton lines beneath four diverse climatic conditions. Three strains NIA-94, NIA-95 and NIA-96 and two commercial check varieties in Sindh province of Pakistan viz. Sadori and CRIS-342 were planted under four different locations Tando Jam, Mirpurkhas, Sakrand and Ghotki environment conditions. Seed cotton yield data was recorded from each location and stability analysis (genotype x environment interaction) was performed. The pooled analysis of variance for seed cotton yield, showed highly significant ($P < 0.05$) differences for varieties, locations and varieties × location interaction. The analysis depicted the significance of both the linear and non-linear components which showed the presence of individually expected and un-expected parts of genotype and environment interaction. Genotypes NIA-95, NIA-94 and NIA-96 produced high average yield (2339, 2280, 2128 Kgha^{-1}) respectively having regression coefficient (bi) value 1.68, 1.29, and 1.218 which indicated that these genotypes were specifically adapted to favorable environments. While, check variety Sadori with bi (0.98) showed wide adaptation to all environments. CRIS-134 showed regression coefficient (bi 0.714) somewhat close to unity 1.0 can be considered wide adaptable to some extent.

Introduction

Cotton is developed in tropical and sub-tropical agro-ecological zones. Rapidly changing and unpredictable climatic conditions demand to identify and introduce more stable cotton genotypes with specific adaptation to specific environments (Iqbal *et al.*, 2018). It is essential to evaluate adaptation and yield stability of promising genotypes across environments. The yield potential of a genotype is the outcome of its interface with the presented environment. The strong effects of ecological factors throughout different phases of crop development, hence genotypes vary broadly in their response to climate (Sial *et al.*, 2000; Bull *et al.*, 1992). Study was carried out with a view to find out the effect of G×E interaction on the yields of new cotton genotypes to identify the firmest and modified genotypes. Sustainable yield requires stable cultivars. Plant breeding is essential phase to recognize firm and extra adjustable strains/genotypes. The learning of stability in cotton is indispensable component of plant breeding earlier to the launch of latest crop variety, generally difference of sites and years are important for sufficient estimates regarding genotypes.

Cotton production requires identification and crop growing of firm cultivars. Genotypes × environment (G×E) interactions are of main concern to plant breeders for rising better and stable strains (Tuteja *et*

al., 2006). Assessment the constancy and flexibility of genotypes transversely diverse atmosphere situation is essential for initiate and advice of latest crop variety which assurance their elevated flexibility. Plant breeders assess germplasm at various locations in different trials to find out the adaptability of genotypes and to propose the cultivars to dissimilar locations (Maleia et al., 2017).

The principle of the work is to estimate the performance of the developed genotypes for stability in cotton yield over dissimilar climatic conditions. Keeping in view the above facts, this research was conducted for evaluating the potential of developed lines for stability and profitable crop growing across different locations in Sindh province.

Materials and Methods

Multi-location trials of cotton strains were carried out during two consecutive years 2018 and 2019. The experiments were conducted at 04 different locations (TandoJam, Mirpurkhas, Sakrand and Ghotki) in Sindh, Pakistan. Five cotton genotypes. Three advanced lines namely; NIA-94, NIA-95 and NIA-96 and two were standard cultivars Sadori and CRIS-342. The experiments were conducted in randomized complete block design with three replicates. The size of the plot measured was 15' x 20' sq. ft, comprising of eight rows 75 cm distance apart for each entry. The cultural practices were done as and when required. The data collected and analyzed separately for each location and subjected to analysis of variance following (Steel et al., 1997). The values presented are mean of three replicates±standard error (SE). Stability analysis of genotypes was completed for yield data from replication trials at multi-environments. Analysis comprised of site wise analysis of variance (ANOVA) and the combined analysis of variance for any place/ environment (Pooled ANOVA). Stability traits were figured out by following the stability model given by (Eberhart and Russell, 1966).

Results and Discussion

Stability study helps in perceptive the adaptability of genotypes over diverse ecological conditions and the recognition of adjustable genotypes. (Dewdar, 2013). Combined ANOVA for seed cotton yield (Table 1) revealed highly significant variation with the genotypes, environments and genotype × environment

(G×E) interaction. Highly significant difference among genotypes might be due to distinction in their inherited frame and varied natural history of beginning. The highly significant differences in sites indicated the presence of variation in the current environment. The highly significant interaction among genotypes and environments may be either a cross over or a non-cross over nature. The pooled analysis revealed the significance of both the linear and non-linear (pooled deviation) components which indicated the presence of both foreseeable and un-foreseeable components of genotypes and environments interaction (Table 2). Farias et al. (2016) evaluated cotton strains in dissimilar locations. This study showed that some varieties had superior performance over a single environment and little performance in others, which shows change in their average performance over multi-environments and revealed significant G×E interaction. Similar trends were observed by (Riaz et al., 2013; Maleia et al., 2010; Moiana et al., 2014; de Carvalho et al., 2015; Pretorius et al., 2015) who evaluated cotton cultivars in various environmental experiments in Pakistan, Mozambique, South Africa and Brazil. Performance of genotypes at various sites is presented in (Table 3). The highest site mean yield was recorded at CRS, Ghotki (2303 Kgha⁻¹) followed by NIA, Tando Jam (2172 Kgha⁻¹). The results reflected that these sites had favorable environment for higher yield. The lowest yields were obtained at CRI, Sakrand (2089 Kg ha⁻¹) and CRS, Mirpur Khas (2045 Kgha⁻¹) respectively depicting that these sites had unfavorable environments for higher seed cotton yield. Mean yield of genotype NIA-95 in general performed better (2339 Kgha⁻¹) than the other genotypes across all four locations while NIA-96 as poorest genotype (2128 Kgha⁻¹). The results achieved in this study satisfied one of the breeder's goals for selecting stable genotypes with acceptable seed cotton yield over a range of environments. The stability parameters calculated for yield of cotton genotypes are presented in Table 4. Among the genotypes, NIA-95, NIA-94 and NIA-96 produced high average yield (2339, 2280, 2128 Kgha⁻¹) respectively and whereas these genotypes have regression values higher than 1.0 possesses specific adaptation to favorable or high yielding environments and deviation from regression line (S²d~0) was close to unity '0'indicated that these genotypes possess general stability. These results are in accordance with the findings of some previous studies (Killi and Harem, 2006; Khan et al., 2007; Naveed et al., 2006; Riaz et al., 2013) which reported

Table 1: *Combined analysis of variance for seed cotton yield (kgha⁻¹) of cotton genotypes tested over different environments.*

Sources	Degree of freedom (d.f)	Mean square (m.s)
Years	1	377217**
Locations	3	384067**
Genotypes	4	597583**
Year × Location	3	403775**
Year ×Location× Genotype	12	73325**
Error	78	11459
Total	119	

*, **, ns; significant at 5%, 1% probability levels and non–significant, respectively

Table 2: *Pooled analysis of variance.*

Sources	DF	MS	F-value
Total	19	35387.789	
Environments (Env.)	3	64008.000	
Varieties (Var.)	4	99594.000**	40.268
Var. × Env.	12	6830.667	
Env. + Var. × Env.	15	18266.133	
Env. (Lin.)	1	192027.984	
Var. × Env. (Lin)	4	14307.871**	5.785
Pooled Dev.	10	2473.253	0.216
Pooled Error	64	11459.390	

F–test: Deviation from Regression: Pooled Dev. MS / Pooled Error MS, Var.x Env. (Lin) = Var. x Env. (Lin) MS / Pooled Dev.MS: Varieties = Varieties / Pooled Dev.MS.

Table 3: *Seed cotton yield (Kgha⁻¹) of cotton genotypes tested different locations over two years during kharif (2018 and 2019).*

Locations	NIA-94	NIA-95	NIA-96	Sadori	CRIS-324	Site mean
NIA, Tando Jam	2225 c-f	2368 bc	2117 c-g	2278 b-e	2189 c-f	2172 b
CRS, Mirpur Khas	2067 c-g	2150 c-g	1975 d-g	1930 e-g	1969 d-g	2045 c
CCRI, Sakrand	2195c-f	2183 c-f	2047 c-g	1960 d-g	1913 fg	2089 c
CRS, Ghotki	2832 a	2958 a	2627 ab	1947 d-g	2237 c-f	2303 a
Genotypic mean	2280 a	2339 a	2128 b	1955 c	2059 b	

the stability and G×E interaction in genotypes of cotton and the effect of distinct environments on seed cotton yield to understand their adaptation to different environments. The lines NIA-95, NIA-94 and NIA-96 produced high average yield (2339, 2280 and 2128 kgha⁻¹, respectively having regression coefficient (b_i) value 1.68, 1.29 and 1.218 which indicated that these genotypes were especially adapted to favorable environments. While check variety Sadori with b_i (0.98) showed wide adaptation to all types environments. CRIS-134 showed regression coefficient (b_i 0.714) somewhat close to unity 1.0 can be considered as wide adaptable to some extent. Every year a huge number of newly developed genotypes are being assessed for their yield stability and suitability for particular environmental conditions. This is the pre-requisite activity to approve and recommend the new cotton varieties for general cultivation in the country (Iqbal *et al.*, 2018).

Table 4: *Stability parameters for seed cotton yield (Kgha⁻¹) genotypes tested under different environments over two years.*

Source	Over all mean seed yield (Kgha⁻¹)	Regression coefficient (b_i)	Deviation from regression coefficient (S^2d)
NIA-94	2280 a	1.29	0.005
NIA-95	2339 a	1.68	0.000
NIA-96	2128 b	1.218	0.001
Sadori	1955 c	0.98	0.005
CRIS-324	2059 b	0.714	0.002

Conclusions and Recommendations

From present study it is concluded that the genotypes Sadori and CRIS-134 with low regression coefficient and deviation from regression coefficient are wide adaptable to the range of environments. While the cotton genotypes NIA-94, NIA-95 and NIA-96 showed highest regression coefficient values, which suggest their specific adaptation to favorable environments.

Novelty Statement

Cotton is considered as a life line of economy of Pakistan. There is lot of studies on stability analysis. The stability assessments of advance cotton genotypes across the different environmental conditions of Sindh province are rare. Further the germplasm used in present study are novel and never included in such kind of studies before.

Author's Contribution

ZAD developed basic ideas, experiment/theoretical setting, preparation of writing research paper. SA helped in the execution of experiment. MR contributed in data analysis and technical assistance regarding manuscript review.

Conflict of interest
The authors have declared no conflict of interest.

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