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Phenotypic Stability in *Gossypium hirsutum* L. for Yield, Ginning Out Turn and Staple Length in Multan Cotton Zone

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Seed cotton yield, ginning out turn percentage and fibre length data from six locations in Multan Zone were evaluated for stability. All these cultivars under study were stable for ginning out turn percentage in these environments. S-12, MNH93 and B557 were identified as the most stable for yield performance. Utilisation of MNH321 was recommended in hybridization to have better stability for ginning out turn percentage. S-12 was identified to be the most stable for staple length. In conclusion for better stability in yield of seed cotton, ginning out turn percentage and staple length, utilisation of MNH93, B557, MNH321 and S-12 in the breeding programmes are recommended.

Key words: *Gossypium hirsutum,* Yield, Ginning out turn, Staple length.

Introduction

Assessment of genotype environment interaction is assuming importance in plant breeding programme to evaluate genotypes for their adaptability. Environmental factors such as soil properties, moisture, temperature, relative humidity etc. vary in Multan zone; consequently, release of genotypes with consistent performance for a range of environments is important to achieve stable production.

At present, very few cotton breeding programmes employ any stability parameters as a selection criterion. So far as analysis is concerned, a number of statistical methods are available for estimating phenotypic stability (Finlay and Wilkinson 1963; Eberhart and Russell 1966; Perkins and Jinks 1968). Several of these have been summarised and compared by Lin *et al* (1986). The Eberhart and Russell method has been extensively used by crop breeders to study genotypic stability. The regression of genotype means on environmental means, calculated as the means of all genotypes on that environment, was first proposed by Yates and Cochran (1938). This method was later modified and used by Eberhart and Russell (1966) as partitioning, sums of squares for environment + (Genotype x environment) into linear component between environments with one degree of freedom, a linear component of (genotype x environment) interaction with t-1 degree of freedom (t=number of genotypes) and deviation from regression for each genotype with S-2 degree of freedom (S=number of environments). Gens *et al* (1987) while studying *Gossypium hirsutum* L cultivars for stability found that fibre quality scores were less responsive to environmental changes than yield. Seth *et al* (1987) observed that homozygosity was more stable than heterozygosity for ginning out turn and lint index. They also found that Acala SJ x H655 was the most stable hybrid. A systematic study to assess stability in performance of cotton genotypes in Multan zone was lacking. Present study was, therefore, planned to determine the stability of ten genotypes grown at six locations in Multan zone.

Materials and Methods

The experiment was conducted by the Cotton Research Station, Multan during, 1992-93. Ten genotypes of different origin *viz.* MNH319, MNH321, MNH 324, MNH333, S-12, MNH93, MNH329, B557, NIAB78 and CIM240 were grown at six locations i.e. Vehari, Khanewal, Multan, Thatta Gurmani, Kot Chutta and Haroonabad using triplicated Randomised Complete Block Design. The plot size at each location was 50' x 20'. The seed cotton yield was recorded from each plot and calculated in kilograms per hectare. Ten random samples from each genotype, replication and locality were ginned on single roller electric gin machine. The lint from these samples were weighed and ginning out turn percentage was calculated. Lint staple length was measured by digital fibrograph model "530" at 2.5 percent span length and uniformity ratio at 50 percent divided by 2.5 percent was based on five specific readings.

Analysis of variance was conducted over location as out lined by Steel and Torrie (1980). Significance of genotype x environment mean squares allowed to proceed for stability analysis. Four stability parameters were calculated for each genotype and for each trait i.e. regression coefficient (b_i), variance of deviation from regression (S^2d_i) as proposed by Eberhart and Russell (1966), ecovalance Wi^2 as proposed by Wricke

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(1962), formula narrated by Crossa (1990) and stability interaction variance "S^2" given by Shukla (1972).

Results and Discussion

Yield (kg ha^{-1}). Mean squares from analysis of variance of the data for six locations shown in table 1 revealed that genotypes, environments and genotype x environment interaction (GxE) were highly significant. The highly significant (GxE) interaction allowed to proceed with further analysis.

The data in table 2 also indicated highly significant mean squares due to environment + (genotype x environment) which further confirmed the presence of (GxE) interaction and indicated variable response of the ten genotypes in different environments. Both linear (environment linear and regression) and non linear (pooled deviation), components of GxE interaction were highly significant which indicated that the difference in the performance of these genotypes was due to difference in their genetic make up and also the genotypes differed in their response to the environment under which they were planted. Table 3 indicated that S-12 was at the top having mean value (over locations) of 2828 kg seed cotton per hectare which was followed by MNH 93 (2736 kg ha^{-1}) and these two were statistically similar in performance according to Duncan's Multiple Range Test.

According to Eberhart and Russel (1966) a stable genotype is one which has maximum mean unit regression and small deviation from regression. The regression coefficient for MNH93 was closest to 1.0 (Table 4). As far as variance of deviations from regression is concerned, MNH93 had comparatively lower value than high mean value of genotype S-12. According to Finlay and Wilkinson (1963), the cultivars with a regression coefficient approaching 1.0 would be stable over a range of environment. However, Eberhart and Russell (1966) proposed that regression coefficient (b_i) should be a parameter of response and variance of deviations from regression coefficient (S^2d_i) as a parameter of stability. Being a parameter of response, the regression coefficient b_i of MNH93 was less responsive to the environmental changes and hence more adaptive. The ecovalance (Wi^2) i.e. contribution of each genotype to GxE interaction, the sum of square and interaction variance (S^2) were also comparatively lower for MNH93. The lowest value for variance of deviation from regression was observed in B557 hence it was a more stable genotype but its mean (over location) was lower (Table 3). The stability of B557 for yield was confirmed from its lowest ecovalance and stability interaction variance (S^2). The B557 had b_i value near to unity so it was less responsive to changes in environment. Variety B557 has been a commercial variety of Multan zone since 1975 and was used for cultivation in problem soils and was less responsive to high yielding inputs. This behaviour of B557 was obvious from its maximum stability over a range of environments. If a plant breeder wants to create stability of seed cotton yield for Multan zone it is recommended to use MNH93 and B557 as progenitor. The S-12 having highest yield per hectare had b_i value near to unity but larger value for the deviation from regression (S^2d_i), contrary to the findings of Eberhart and Russell (1966). MNH329 had b_i much greater than unity hence it is adaptive to high yielding environment.

Ginning out turn% (G.O.T.). Table 1 revealed that mean squares for genotypes, environment and genotype x environment interaction were highly significant for G.O.T. percentage.

Table 2 revealed that environment + (varieties x environment) were highly significant which indicated that the genotypes behaved differently in different environments for ginning out turn percentage. The difference in ginning out turn percentage was due to genetic make up. The environment (linear) and regression mean squares were highly significant against pooled

Table 1

Mean square of ANOVA for yield, ginning out turn and staple length for six locations

Source	d.f.	Mean square		
		Yield	G.O.T.	Staple length
Genotype	9	842773.55**	202.2978333**	5.446791667**
Environment	5	17567783.82**	108.057789**	9.428995**
Replication in environment	12	561045.7667**	43.46683333**	0.2831375N.S.
Genotype x Environment	45	379252.5984**	3.870232333**	0.4132124**
Error	108	60620.01222	1.924055972	0.21675062

** Highly significant; N.S. Non significant.

Table 2
Pooled analysis of variance of GxE of yield, G.O.T. and staple length

Source	d.f.	Mean square		
		Yield (kg ha^{-1})	G.O.T. (%)	Staple length (mm)
Total	59	635530.3395	14.3227678	0.64717582
Varieties	9	280924.5167*	67.43261111**	1.817911856**
Environment (Varieties x Environment)	50	699359.3876**	4.762996**	0.436443334**
Environment(Linear)	1	29279100.22**	180.0594283**	15.66333333**
Regression	9	485727.1701**	2.545843111**	0.169644843 NS
Poold deviation	40	130078.5492**	0.879090012 NS	0.115800744*
MNH-319	4	134561.5766**	1.82332512 NS	0.04074412 NS
MNH-321	4	221733.9361**	0.433026978 NS	0.206683859*
MNH-324	4	77678.7113*	0.545055279 NS	0.078696093 NS
MNH-329	4	108536.7769**	0.851258929 NS	0.26353683**
MNH-333	4	106539.3366**	1.314135153 NS	0.122867434 NS
S-12	4	219776.3907**	0.173997134 NS	0.033806197 NS
MNH-93	4	135025.7345**	0.303435443 NS	0.081616284 NS
B557	4	61713.86518*	2.075046713 NS	0.126112435 NS
NIAB78	4	98954.3847**	1.017693161 NS	0.0145550778 NS
CIM-240	4	136264.7794**	0.25392562 NS	0.058268986 NS
Pooled error	120	22861.38506**	2.026111236	0.072280863

** Highly significant; * Significant; NS, Non significant.

Table 3
Mean (over location) for yield, G.O.T. and staple length in Multan cotton growing zone

Genotypes	Yield (kg ha^{-1})	G.O.T. (%)	Staple length (mm)
MNH319	2376.68 cd	42.64 ab	28.16 cd
MNH321	2349.33 cd	43.50 a	28.5 ab
MNH324	2348.23 cd	39.01 d	28.58 a
MNH329	2651.78 ab	41.74 b	26.84 f
MNH333	2334.84 d	39.18 d	28.46 abc
S-12	2828.00 a	40.75 c	28.48 abc
MNH93	2737.50 a	36.49 e	28.22 bcd
B-557	2531.12 bc	32.97 f	28.07 d
NIAB78	2111.77 e	35.87 e	27.57 e
CIM240	2494.50 bcd	36.85 e	27.63 e
Grand Mean	2476.376	38.99	28.049

NB, Figures in one column with same letters are not much different.

deviations. The non significant (P<0.05) pooled deviation mean square indicated that ginning out turn percentage was less affected by a change in the environment which confirmed the findings of Gens *et al* (1987) who observed that fibre quality were less responsive to environmental changes. As pooled deviation mean squares value was non significant, all the genotypes included in the experiments were stable for ginning out turn percentage which is also evident from non-significant variance of deviations from regression (S^2d_i) of all genotypes (Table 4). Mean over location (Table 3) showed that MNH321 was at the top, followed by MNH319. Table 4 indicated that MNH333 and B557 had the b_i value near unity hence they were comparatively less responsive to changes in the environment. MNH321 having larger mean, lower value of variance of deviation from regression, lower ecovalance and stability variance can be used in crossing programmes for breeding stable genotypes for ginning out turn percentage.

Staple length. Staple length showed highly significant differences for genotypes, environments and genotype x environment interaction mean square (Table 1).

Pooled analysis of variance indicated that the value of mean squares for environment + (genotype x environment) was highly significant which showed that genotype behaved dif-

Table 4
Stability parameters for yield, G.O.T. and staple length of *Gossypium hirsutum* L.

Cultivars	Stability parameters			
	b_i	S^2d_i	W^2_i	S^2
Yield (kg ha^{-1})				
MNH-319	1.436230181	111700.1 915**	592584.4179	132343.6902
MNH-321	0.964327539	198872.551**	890661.5789	206862.9804
MNH-324	1.031656871	54817.32624*	313649.0729	62609.85392
MNH-329	1.272293137	85675.39184**	651232.7579	147005.7752
MNH-333	0.784693823	83677.95152**	561885.7379	124669.0202
S-12	0.944428198	196915.0056**	888147.6069	206234.4874
MNH-93	1.00706727	112164.3495**	540249.1729	119259.8789
B-557	1.017354472	38852.48012*	247737.2826	46131.90634
NIAB-78	0.986672024	76092.99964**	396337.6376	83281.99509
CIM-240	0.855276487	113403.3943**	606383.8849	135793.5569
G.T.O. (%)				
MNH-319	1.380124342	-0.202785524 NS	9.895062833	2.312442963
MNH-321	1.312017013	-1.593084258 NS	3.4850695	0.70994462
MNH-324	1.611371883	-1.481055957 NS	8.910402833	2.066277963
MNH-329	1.126629794	-1.174852306 NS	3.693762833	0.762117962
MNH-333	1.015493339	-0.711976082 NS	5.26080862833	1.153892963
S-12	0.406319091	-1.852114102 NS	7.0423095	1.59925463
MNH-93	0.516978575	-1.722675793 NS	5.414702833	1.192352963
B-557	0.951625258	0.048935476 NS	8.342322833	1.924257963
NIAB-78	0.816102502	-1.008418075 NS	4.679702833	1.008602963
CIM-240	0.863338203	-1.772185616 NS	1.3519895	0.176674629
Staple length (mm)				
MNH-319	1.448397532	-0.033718982 NS	0.19747	0.3225929
MNH-321	1.267603746	0.432220757*	0.938903333	0.217617962
MNH-324	0.629157267	0.004232994 NS	0.530193333	0.0115440462
MNH-329	0.80011279	0.189073727**	1.11673	0.262074629
MNH-333	1.373528411	0.048404331 NS	0.71001	0.160394609
S-12	0.969670143	-0.040532483 NS	0.137163333	0.017182962
MNH-93	0.671906789	0.007153181722	0.495073333	0.106660462
B-557	1.588159184	0.051649332 NS	1.046293333	0.244465462
NIAB-78	0.842955948	0.071087675 NS	0.620833333	0.13810062
CIM-240	0.708508193	-0.016194116 NS	0.366163333	0.074432962

*, Significant; **, Highly significant; NS, Non-significant.

ferently in different environments for staple length. The regression (genotype x environment) linear mean square was non-significant which indicated that genotype x environment interactions were non linear type; however, the value of mean squares for pooled deviations was significant (P>0.05) against the error. Non-significant (P<0.05) regression values revealed lack of genetic differences among genotypes for their response to different environments. MNH329 was at the top and was statistically similar to MNH321, S-12 and MNH333 (mean data of Table 3). S-12 had the b_i closest to the unity hence it is less responsive to changes in the environment (Table 4). Stability of S-12 for staple length was confirmed from its lowest mean squares of deviation from regression, ecovalance and stability interaction variance. The statistically highly significant differences of mean squares of deviation from regression for MNH321 and MNH329 indicated that these two genotypes were unstable for staple length. B558 had the highest b_i value hence it was the most sensitive genotype to changes in the environment with respect to staple length.

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