

## Evaluation of Okra-leaf Pak-upland Cottons (*Gossypium hirsutum* L.) for Yield Stability Across Environments

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**Abstract:** Field experiments were undertaken to assess yield stability of some new okra-leaf cotton strains under a wide range of environments. Six okra-leaf upland cotton strains and two normal leaf check varieties, MNH-552 and FH-1000 were planted under six environments. Substantial differences were observed among genotypes for seed cotton yield and yield stability. Regression of seed cotton yield on the environmental index successfully depicted differences among the tested genotypes for yield stability. Okra-leaf genotypes, HR149-552 and HR170 exhibited unit regression coefficient and above average seed cotton yield. Genotypes, HR149-552 and HR170 appeared to be suitable for a wide range of environments. Although the standard normal leaf cultivar FH-1000 produced highest overall average yield, it was less stable across environments as compared to okra-leaf genotypes. Generally okra-leaf strains were better adapted to less conducive environments.

**Key words:** Okra-leaf cotton • yield stability • genotype • environment interaction

### INTRODUCTION

In upland cottons, okra and normal leaf are the two major leaf types. Most upland cotton cultivars grown commercially possess the normal-leaf type. Okra-leaf trait exerts substantial effect on the physiological and canopy characteristics of the host genotype despite having a single major gene ( $L^o$ ) inheritance [1]. Okra-leaf cultivars are characterized by deeply cleft leaves and relatively smaller leaf area. Okra-leaf cottons have relatively less vegetative growth [2], earlier maturity [3], greater flower production [4] and less boll rot [3] than the normal leaf types. Okra leaf cottons have better water use efficiency and lower stomatal conductance [5] and a degree of resistance to *Helicoverpa* spp. and spider mites [6]. In addition, the okra-leaf characteristic may provide higher ambient temperature and lower humidity in the cotton canopy, creating a micro-climate unfavourable for whitefly survival [7]. Breeding for okra-leaf upland cottons have resulted in the development of new okra-leaf strains with good yielding ability and fibre quality [8-10].

Sustainable production requires stable cultivars. Identifying stable and more adaptable strains/cultivars is an important aspect of applied plant breeding. Several methods of estimating genotypic stability across

environments are available [11, 12]. Cotton genotypes have been evaluated for stability in yield [13, 14], CLCuV resistance [15] and seed oil percentage [16].

The present study was initiated to evaluate new okra-leaf strains of upland cotton for stability of yield performance over environments in comparison with normal leaf standard cultivars. Information gathered from this study will help in assessing the potential of okra-leaf upland cottons for commercial cultivation.

### MATERIALS AND METHODS

The experimental material consisted of eight upland cotton genotypes (Table 1) of which six were new okra-leaf strains developed in the okra-leaf breeding programme from 1992 to 2001 at Cotton Research Institute (CRI), Faisalabad and two standard cultivars, MNH-552 and FH-1000.

The experiments were carried out at CRI, Faisalabad for three years; 2002, 2003 and 2004, at two sowing dates, April and June on loam soil. Each sowing date was considered as an environment, making six environments in all. Such a technique is a valid experimental methodology and has been used in several crops including cotton [16] and Brassica [6]. It has been argued

Table 1: List of genotypes used for stability analysis in the present study and their salient features

Sr.	Genotypes	Salient features
1.	HR149-552	Okra leaf strain, near isogenic line of the commercial cultivar, MNH-552 for leaf type.
2.	HR170	Okra, red, hairy leaves, red plant body. Tall erect type with long sympodial branches, late maturing.
3.	HR109-RT	Okra, sparsely hairy green leaves, red stem, twigs, leaf mid rib and veins. Medium tall and sympodial habit.
4.	HR159	Okra, green, sparsely hairy, nectriless leaves. Medium height, sympodial habit and early maturing.
5.	HR-VO-MS	Okra, light green, pilose leaves, medium tall, semi bushy habit.
6.	HR100-Okra	Okra leaf strain, short height, semi bushy in appearance and very early maturing.
7.	MNH-552	Commercial cultivar, medium tall, erect, small bolls, sympodial habit and medium early maturing.
8.	FH-1000	High yielding commercial cultivar developed at CRI, Faisalabad. Medium height, short sympodials, normal medium broad sparsely hairy leaves.

that different sowing dates provide more variable environment than repeating experiments over years for yield and membrane stability [19, 16] seed physical traits [17] and also stomatal conductance [12].

Layout of all the experiments was Randomized Complete Block Design (RCBD) with three replications. Plot size measured 450×225 cm, comprising three rows set 75 cm apart. Distance between plants within rows was 30 cm. Agronomic and cultural practices were those generally applied to cotton crop in the region. Suitable insecticides were sprayed against insect pests to prevent economic injury. Seed cotton was picked after 180 days of sowing and recorded on plot basis.

**Statistical analyses:** 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 regressing yield on the environmental index ( $b_i$ ) and mean performance over environments ( $m_i$ ), following Eberhart and Russell's [11]. Mean seed cotton yield of the genotypes was plotted as dependent variable against environmental index using MS-Power Point.

## RESULTS AND DISCUSSION

Analysis of variance over environments (Table 2) showed significant variation ( $p < 0.01$ ) due to environments, environment (linear) and genotype×environment ( $G \times E$ ). Variation due to  $G \times E$  interaction was further partitioned into linear and non-linear (pooled deviation) components and mean squares for both sources were found significant ( $p < 0.01$ ). Significant  $G \times E$  mean square suggested that environmental interaction was there and cultivars changed their relative ranking for seed cotton yield over environments. Overall pooled deviations were

Table 2: Mean squares obtained from the analysis of variance of eight cotton genotypes across environments for seed cotton yield

Source of variation	DF	Seed cotton yield
Genotypes (G)	7	1411.921**
Environments (E)	5	41193.904**
$G \times E$	35	811.764**
Environment (Linear)	1	205968.339**
$G \times E$ (Linear)	7	1073.505**
Pooled Deviation	32	653.075**
HR149-552	4	278.635 <sup>N.S.</sup>
HR170	4	481.616 <sup>N.S.</sup>
HR109-RT	4	7.416 <sup>N.S.</sup>
HR159	4	255.84 <sup>N.S.</sup>
HR-VO-MS	4	234.202 <sup>N.S.</sup>
HR100-Okra	4	380.896 <sup>N.S.</sup>
MNH-552	4	1078.073*
FH-1000	4	2507.918**
Pooled Error	96	326.696

\*, \*\* = Significant at 5 and 1% levels of probability, respectively, N.S. = Non-significant ( $p > 0.05$ )

significant which were predominantly due to the contribution of two genotypes, MNH-552 and FH-1000. All okra leaf accessions showed non-significant deviations ( $p > 0.05$ ).

### Performance of individual genotypes over environments:

Performance of individual genotypes under various environments is presented in Table 3. Among the six environments, June' 02 and June' 03 were conducive for higher yield. The overall seed cotton yield in individual environments varied considerably and ranged between 2.423 to 12.095 kg plot<sup>-1</sup>.

The genotypes HR149-552, HR170, HR109-RT and the two standards, MNH-552 and FH-1000 produced above average seed cotton yield over environments. The performance of the genotype HR109-RT was above average in all the environments except April' 01.

Table 3: Performance of the upland cotton genotypes under different environments and in individual environments for seed cotton yield (kg plot<sup>-1</sup>)

Entries	Environments						Mean
	April' 01	June' 01	April' 02	June' 02	April' 03	June' 03	
HR149-552	2.163 (5)	2.656 (7)	5.487 (3)	7.515 (2)	5.995 (2)	11.724 (4)	5.923 (5)
HR170	3.050 (2)	4.182 (1)	4.033 (5)	6.224 (4)	7.299 (1)	11.441 (6)	6.038 (3)
HR109-RT	2.311 (4)	3.321 (3)	5.071 (4)	6.993 (3)	5.635 (3)	13.957 (2)	6.215 (2)
HR159	2.138 (6)	2.912 (6)	3.399 (7)	5.008 (6)	5.043 (6)	12.819 (3)	5.220 (6)
HR-VO-MS	2.531 (3)	3.037 (4)	5.837 (2)	5.687 (5)	4.604 (7)	9.090 (8)	5.131 (7)
HR100-Okra	2.115 (7)	2.960 (5)	3.163 (8)	3.689 (8)	3.387 (8)	10.647 (7)	4.327 (8)
MNH-552 (Std)	3.221 (1)	3.761 (2)	3.521 (6)	4.854 (7)	5.188 (4)	15.369 (1)	5.986 (4)
FH-1000 (Std)	1.852 (8)	2.546 (8)	8.099 (1)	10.394 (1)	5.116 (5)	11.715 (5)	6.620 (1)
Mean	2.423	3.172	4.826	6.295	5.283	12.095	5.682
CD 5%	0.333	0.386	1.152	1.427	0.788	1.348	0.510

Std = Standard cultivars, CD 5% is the critical difference for comparing means at 5% level of probability

HR149-552 produced above average yield under April' 02, June' 02 and April' 03 and HR170 under April' 01, June' 01 and April' 03. In general, okra-leaf genotypes performed better under less conducive and April sown (high temperature) environments (Table 3). The standard cultivar FH-1000 was the highest and HR100-Okra, the lowest seed cotton yielder on overall basis.

According to Eberhart and Russell [11], cultivars exhibiting high regression coefficient ( $b_i > 1$ ) have below average stability and such cultivars are expected to perform well under favourable conditions. Similarly, cultivars with low regression coefficient ( $b_i < 1$ ) have above average stability and are expected to perform better in less favourable environments. In addition, Bilbro and Ray [13] 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 performance within environments. Results of the regression analysis are given in Fig. 1. Regression of seed cotton yield on the environmental index successfully depicted differences among the tested genotypes. Only FH-1000 and HR149-552 exhibited unit regression coefficient ( $b_i$ ) for seed cotton yield. Regression coefficient for the genotypes; HR109-RT, HR159 and the standard MNH-552 was above unity and that for HR170, HR-VO-MS and HR100-Okra below unity.

Genotypes HR149-552 and HR170 exhibited high stability over environments and performed better than the standard cultivar FH-1000 in the less conducive environments. These genotypes did not significantly interact with the environments and remained stable in their yield performance.  $R^2$  for both the genotypes was above 80%, indicating reliability of their linear response. These genotypes could be a good choice for cultivation

under a wide range of environments. Genotypes HR159 and HR109-RT showed moderately low average stability over environments. Despite performing well under favourable conditions, both the genotypes responded well in less conducive environments and produced more seed cotton yield than the standard cultivar, FH-1000 under those environments. Coefficient of determination for HR109-RT and HR159 was 75 and 71 percent, respectively. Genotypes, HR-VO-MS and HR100-Okra exhibited above average stability,  $R^2$  being 57 and 71%, respectively. These genotypes were suitable for less favourable conditions. Standard cultivar MNH-552 exhibited medium stability despite producing high overall seed cotton yield. Coefficient of determination for MNH-552 was <60%, indicating less reliability of linear response. MNH-552 may be suitable under favourable conditions. Although, the other standard cultivar FH-1000 had the highest mean yield over environments, it exhibited poor stability across environments and articulated significant deviation from linear response.  $R^2$  for FH-1000 was <60%, suggesting low reliability of linear responses.

Genotypes showed variable responses to environments. HR149-552 was morphologically a near isogenic line of standard cultivar MNH-552, but the two cultivars showed wide difference in yield performance due to their differential adaptability to environments. Interestingly, okra-leaf accession was adapted to one set of environments (April' 02, June' 02 and April' 03) and the normal leaf accession to a different set of environments (April' 01, June' 01 and June' 03). This suggests that studies may be undertaken on these genotypes to further assess if the variation in adaptability was the function of changes in leaf morphology and physiology.

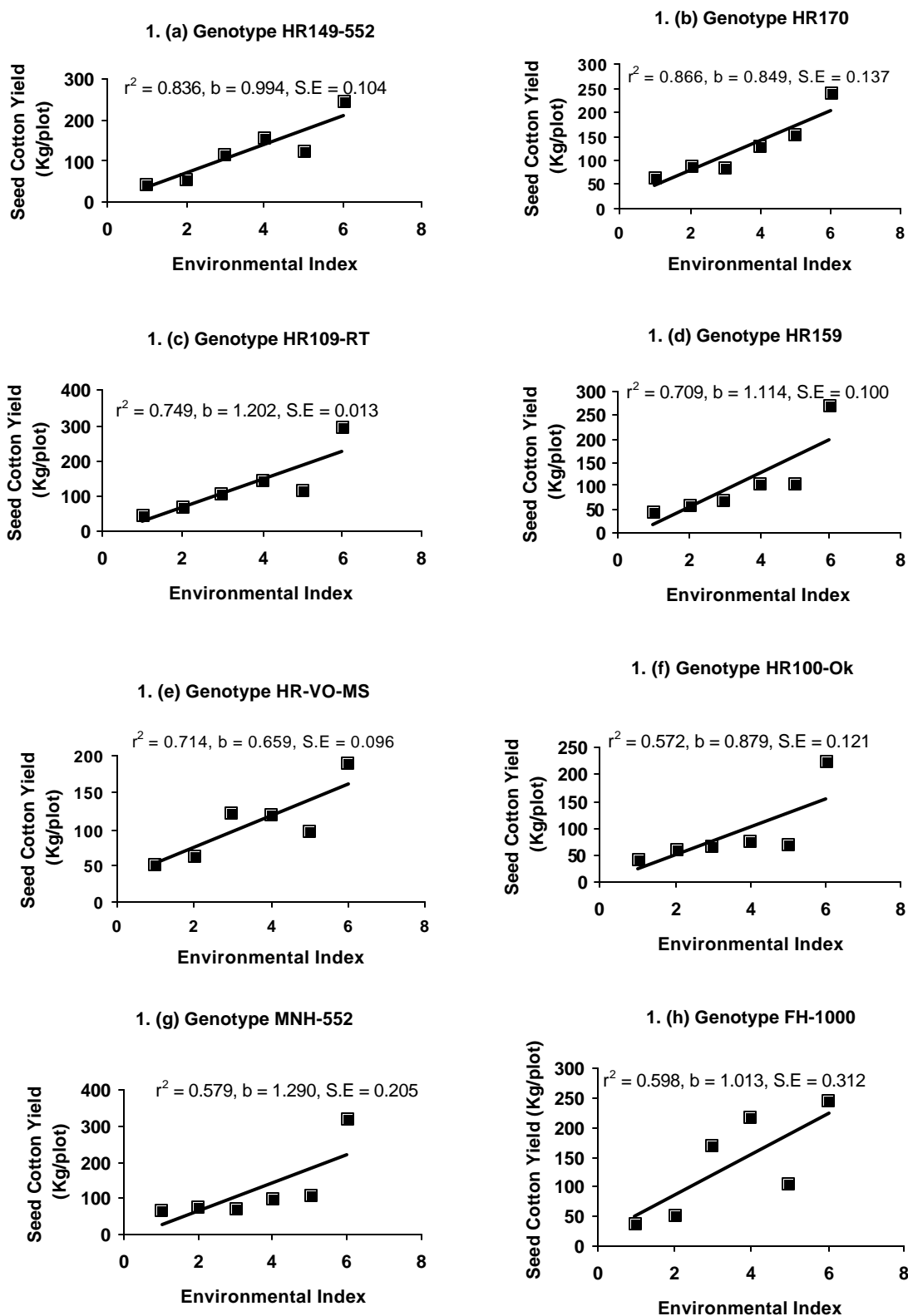


Fig. 1: Performance of cotton genotypes over different environments

## CONCLUSION

It is concluded that the okra-leaf genotypes have the potential to compete with broad leaf genotypes for yield stability. Among the okra-leaf strains, HR149-552 and HR170 possessed yield stability over a range of environmental conditions. Efforts may be directed towards their evaluation in larger plots and at farmer's field to further gain confidence in releasing these strains as commercial upland cotton cultivars.

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