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Studies on stability parameters and sustainability index for selecting stable genotypes in Asiatic cotton (*Gossypium arboreum*)

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ABSTRACT

Comparative studies on stability parameters and sustainability index for selecting stable genotypes in Asiatic cotton (*Gossypium arboreum* L.) was carried out according to Eberhart and Russell model with sustainability index model. Stability analysis was carried out on seven *Gossypium arboreum* genotypes for seed cotton yield, seed index, lint index, number of bolls/plant, boll weight, GOT, 2.5% span length, micronaire and bundle strength on three years data, viz. 2004, 2005 and 2006. Based on the linear component (bi), non-linear response (S^2di) and high mean performance (x), the genotypes LD 861 and CISA 614 were found stable for seed cotton yield. While based on sustainability index and best performance, the only genotype CISA 614 was found to be stable. For other traits like seed index, lint index, GOT, no. of bolls/plant, boll weight and micronaire, the deviation from regression was non-significant and on the basis of sustainability index, the variety CISA 614 was found stable having sustainability index more than 80%. For seed index, GOT, micronaire, 2.5% staple length, bundle strength, all the genotypes recorded very high sustainability index, which indicated that these characters are least influenced by the environmental factors, however, the genotype CISA 614 has high sustainability index for 2.5% span length, whereas very high sustainability index was expected. For many characters the results were found in conformity based on Eberhart and Russell model and hence the sustainability index model may be used for selecting the stable genotypes, however for 2.5% staple length it was found contrary.

Key words: Asiatic cotton, Stability parameters, Sustainability index, Yield

Seed cotton yield and its component traits are highly affected by environment. With the statistical and biometrical techniques developed to estimate stability parameters, it would be possible to determine genotypic response for wider adaptability. Techniques for GE analysis based on linear regression can be informative when GE interaction has high linear association with the environmental index but when the non-linear component is also significant (Finlay and Wilkinson 1963 and Verma *et al*. 2007). The analysis based on Eberhart and Russell model being relatively simple has been widely used for stability analysis. Estimation of GE interactions consists of complementary procedures of classification and grouping the genotypes according to their response in different environments (Nehra and Bhunia 2002 and Singh and Agarwal 2003). Genotype × environment interaction is important in understanding the stability in yield of a particular genotype before it is being recommended for a given situation (Verma *et al*. 2008)

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The present investigation was therefore conducted to find out the stability for seed cotton yield and its component traits of promising arboreum genotypes and to compare model of Eberhart and Russell and the new model based on sustainability index used by other workers in cotton (Verma *et al*. 2007 and Tuteja 2006).

MATERIALS AND METHODS

The experimental material consisted of 6 promising high yielding Asiatic cotton (*Gossypium arboreum* L.) genotypes namely FDK103, LD 866, LD 816, CISA 310, CISA 614 and HD 402 representing north zone, i e Faridkot, Ludhiana, Sirsa and Hisar and one cheek variety, i e HD 123. These genotypes were grown in a randomized block design with three replications during *kharif* season of 2004, 2005 and 2006. The plot size was 6.0 m × 2.7 m with four rows spaced 67.5 cm apart in each environment namely, Faridkot, Ludhiana, Sirsa and Hisar and plant to plant spacing of 30cm. The data were recorded on seed cotton yield (kg/ha), lint yield (kg/ha), number of bolls/plant, boll weight (g), GOT (ginning outturn), seed index, lint index, quality traits like 2.5% span length (mm), micronaire and bundle strength (g/tex). The seed cotton yield was recorded on plot basis and

Table 1 Estimates of stability parameters seed cotton yield and its components in *G. arboreum* genotypes

Genotype	Yield			Seed Index			Lint Index			GOT			Lint yield		
	Mean	bi	$S^{-2}di$	Mean	bi	$S^{-2}di$	Mean	bi	$S^{2}di$	Mean	bi	$S^{2}di$	Mean	bi	$S^{-2}di$
FDK 103	1 839	1.16	0.08	5.00	1.02	0.07	2.93	0.45*	0.04	36.97	0.58	0.49*	672.12	1.10	0.18*
LD 866	1 593	0.94	0.01	4.92	6.48	0.07	3.09	0.68	0.03	38.46	0.72	0.00	613.40	0.89	0.03
CISA 310	1 785	1.31	0.09	5.27	2.36*	0.01	3.47	1.40*	0.09	39.78	1.26	0.82*	718.30	1.40*	0.16
LD 861	1 963	0.34*	0.11	4.97	-0.64*	0.03	3.27	1.16	0.26	39.59	1.79*	0.18	774.04	0.36*	0.00
CISA 614	2 356	0.35*	0.13	5.61	1.48	0.58	3.47	1.22	0.37	38.24	0.40	0.43	901.34	0.31*	0.19*
HD 402	1 875	1.58*	0.001	5.26	0.42	0.76	3.38	1.16	0.07	39.02	0.78	0.87*	726.53	1.43*	0.00
HD 123	1 792	1.33	0.40	5.26	1.86*	2.99*	3.18	0.93	0.12	37.77	1.48	0.15	688.24	1.51	0.33*
Pooled mean	1 881.35			5.18			3.26			38.55			727.71		
SE	0.15	0.34		0.20	0.80		0.13	0.37		0.12	0.65		0.65	0.35	
	No. of bolls			*Boll wt.*			*2.5% Span length*			*MIC*			*Bundle strength*		
FDK 103	30.61	2.16	3.61*	2.12	0.90	0.001	19.83	0.81	0.00	7.17	1.63	0.10	17.00	0.76	0.03
LD 866	28.00	2.10	0.70	2.34	1.18*	0.02	19.87	0.83	0.39*	6.93	0.20	0.00	17.03	0.91	0.26
CISA 310	28.11	1.30	2.35	2.29	0.91	0.08	18.37	0.42*	0.01	7.57	1.60	1.20*	15.57	–1.10*	0.88*
LD 861	28.69	0.87	0.56	2.26	0.96	0.32*	18.53	1.10	0.05	7.07	1.64	0.44*	16.43	1.38	0.01
CISA 614	32.44	0.70	0.71	2.51	0.74	0.20	21.33	1.52*	0.20*	7.03	0.51	0.03	17.27	2.36*	0.94*
HD 402	29.24	0.51	0.86	2.16	1.33	0.08	21.80	1.42	0.02	6.60	0.03*	1.97*	17.67	2.65*	0.15
HD 123	28.36	–0.01	1.73	2.43	0.98	0.37*	17.60	0.91	0.03	7.63	1.38	2.08*	14.17	0.02*	0.14
Pooled mean	29.35			2.30			19.62			7.14			16.45		
SE	0.24	1.23		0.11	0.39		0.59	0.31		0.26	0.91		0.33	0.59	

converted into kg/ha. After ginning, the lint samples were tested for 2.5% span length, micronaire and tenacity (g/tex) on high volume instrument (HVI) as per ASTM (1998).

The data were analyzed for stability parameters as per Eberhart and Russell (1966). The significance of stability parameters (bi) and its deviation from unity were determined by t-test. The sustainability indices were calculated by following the formula used by earlier workers (Nehra and Bhunia 2002, Singh and Agarwal 2003 and Gangwar *et al*. 2004).

$$SI = \frac{Y - \sigma n}{Y_M} \times 100$$

where Y, Average performance of a genotype; σn, Standard deviation and Y_M is the best performance of a genotype in any year.

The values of sustainability index were divided arbitrarily into five groups, viz. very low (up to 20%), low (21-40%), moderate (41-60%), high (61-80%) and very high (above 80%).

RESULTS AND DISCUSSION

Stability analysis indicated that genotypes and environment differed significantly for all the characters except seed index and lint index. Genotypes × environment interaction was significant for all the characters except for boll weight and lint index indicating differential expression of genotypes for the characters studied.

As per Eberhart and Russell model a variety is considered to be stable if it shows high mean performance with unit regression coefficient (bi = 1) and minimum deviation (non-significant) from the regression line (S^2di). For seed cotton yield none of the genotypes were found stable. The varieties LD 861 and CISA 614 exhibited better performance and bi <1.0 indicating their below average responsiveness, suitable for poor environments (Table 1). However, the variety CISA 614 was found stable for seed index, lint index, GOT, no. of bolls, boll and weight. The regression for genotypes LD 866, LD 861, CISA 614, HD 402 and HD 123 was found unity for lint index while the deviation from regression was nonsignificant. For GOT, the genotypes LD 866, HD 123 were found stable, having unity regression and non-significant deviation from regression while the genotype CISA 614 had regression less than unity but deviation from regression non significant indicating that this genotypes may also be considered as stable for poor environments. For boll weight (g), the genotypes CISA 310 and CISA 614 were found stable with unity regression and non-significant deviation from regression. The genotypes FDK 103, and DH 402 were stable for 2.5% staple length, while for micronaire the genotypes FDK 103 and CISA 614 were found to be stable. In case of bundle strength (g/tex), the genotypes FDK 103, LD 866 and LD 861 were stable, however they had lower mean values than HD 402 and CISA 614. Similar results have been reported for stability of cotton yield by many workers (Singh *et al.* 2012, Nizam *et al.* 1988 and Tuteja 2006).

The estimates of sustainability index analysis of variance for seed cotton yield and other characters revealed significant differences over the years indicating presence of enough genetic variability in the genotypes under study. The variety CISA 614 recorded the mean seed cotton yield of 2 356 kg/ha with very high sustainability index of 81% indicating best performance of this variety (Table 2). The best performance coupled with high value of sustainability index could be taken as the indication of close proximity between the best performance and the average performance over the years. The second best variety LD 861 recorded mean performance of 1 963 kg/ha and suitability index of 78 percent indicating its better performance. The HD 402 recorded mean performance of 1 875 kg/ha and sustainability index of 55 percent indicating its inconsistent performance over the years or this variety may give better yield performance under favorable conditions only. The same was confirmed during 2005-06 when the varieties CISA 614, HD 123 and HD 402 recorded the highest seed cotton yield of 2 606 kg/ha, 2 412 kg/ha and 2 298 kg/ha, respectively, similarly the varieties LD 866 and FDK 103 recorded highest yield of 1 883 kg/ha, 2 222 kg/ha respectively and also sustainability index (65.6%) indicating stability of the varieties over the years. However, as per the Eberhart and Russell model the varieties HD 123, LD 861 showed significant deviation from regression (S^2di) indicating that although being higher yielder were found to be unstable for this trait.

For seed index the variety CISA 614 recorded the highest mean value of 5.61 as well as sustainability index of 88.0 per cent. The other stable varieties were FDK 103, LD 866, CISA 310, LD 861, HD 402 and HD 123. On the contrary, the linear component was non-significant for all the varieties except CISA 310, LD 861 and HD 123, whereas deviation from regression was significant for HD 123. For lint index, all the varieties recorded the higher sustainability index which indicated that this character is least influenced by the

Table 2 Estimates of Sustainability index based for seed cotton yield and its components in G. arboreum genotypes (mean of 3 years)

Genotype	Seed cotton yield(kg/ha)				Seed Index				Lint Index				GOT			
	Mean	σn	Y_M	Sustain-ability index (%)	Mean	σn	Y_M	Sustain-ability index (%)	Mean	σn	Y_M	Sustain-ability index (%)	Mean	σn	Y_M	Sustain-ability index (%)
FDK 103	1 839	457	2 222	62	5.00	0.29	5.3	89	2.93	0.20	3.1	87	37.0	1.13	38.5	93
LD 866	1 593	364	1 883	65	4.92	0.21	5.0	94	3.09	0.25	3.4	84	38.5	1.27	40.0	93
CISA 310	1 785	533	2 253	56	5.27	0.56	5.8	82	3.47	0.51	4.0	73	39.7	2.51	42.9	87
LD 861	1 963	242	2 202	78	4.97	0.24	5.1	92	3.27	0.40	3.8	76	39.6	3.13	43.3	84
CISA 614	2 356	238	2 606	81	5.61	0.39	5.9	88	3.47	0.46	3.8	80	38.2	1.43	39.3	94
HD 402	1 875	609	2 298	55	5.26	0.28	5.5	90	3.38	0.47	3.7	78	39.0	2.26	40.4	91
HD 123	1 792	542	2 412	52	5.26	0.56	6.0	78	3.18	0.33	3.4	83	37.8	2.49	41.1	86
Polled mean	1 881				5.18				3.26				38.5			
	Lint yield				*No. of bolls*				*Boll wt.*				*Staple length (mm)*			
FDK 103	672	146.8	830	63	30.6	5.8	36.9	67	2.12	0.25	2.4	78	19.83	1.40	20.9	88
LD 866	613	142.5	714	66	28.0	4.7	33.1	71	2.34	0.29	2.7	76	19.87	1.97	21.8	82
CISA 310	718	232.7	890	55	28.1	4.1	31.4	77	2.29	0.27	2.6	78	19.37	0.76	19.1	97
LD 861	774	88.2	822	83	28.7	3.7	30.3	83	2.26	0.30	2.5	78	18.53	2.02	19.9	83
CISA 614	901	103.6	1013	79	32.4	3.0	34.3	86	2.51	0.24	2.7	84	21.33	2.41	24.1	79
HD 402	726	225.1	928	54	29.2	3.3	31.3	83	2.16	0.33	2.6	70	21.8	2.33	23.9	81
HD 123	688	247.6	992	44	28.4	4.0	30.0	81	2.43	0.31	2.8	76	17.6	1.51	19.1	84
Polled mean	727.7				29.4				2.30				19.6			
			MIC		*Strength (g/tex)*											
FDK 103	7.17	0.41	7.70	88	17.00	0.38	17.50	95								
LD 866	6.93	0.20	7.00	96	17.03	0.48	17.70	94								
CISA 310	7.57	0.92	8.10	82	15.57	0.91	16.50	89								
LD 861	7.07	0.38	7.60	88	16.43	0.58	17.30	92								
CISA 614	7.03	0.33	7.20	93	17.27	1.21	18.50	87								
HD 402	6.6	0.33	7.00	90	17.67	1.18	19.20	86								
HD 123	7.63	0.59	8.10	87	14.17	0.26	14.40	97								
Polled mean	7.14					16.45										

environmental factors. On the basis of best performance and high sustainability index the varieties CISA 310, LD 861, CISA 614 and HD 402 were found to be consistent over the years.

For GOT, all the varieties recorded the higher sustainability index which indicated least interference of the environment. On the basis of best performance and high sustainability index the varieties CISA 310, LD 861, HD 123, HD 402 and LD 866 were found to be consistent over the years. In case of lint yield (kg/ha) the variety recorded the highest mean value of 901 kg/ha as well as sustainability index of 79.0 per cent. The stable varieties were FDK 103, LD 866 and LD 861.

The variety CISA 614 recorded the highest mean value of 30.6 in case of no. of bolls/plant as well as sustainability index of 86 per cent. The other varieties were also in the stable group as per the sustainability index. For boll weight all the varieties recorded the higher sustainability index which indicated that this character is least influenced by the environment factor.

For quality traits like 2.5 % span length, micronaire and bundle strength were found to have high sustainability index. They fell in the high and very high group of sustainability index. For 2.5% span length all the genotypes were placed in very high group, i.e. above 80% while the genotypes CISA 614 showed sustainability index of 79% as its range for the said character was more indicating the influence of environment factors or sampling error for testing of length. For other traits micronaire and bundle strength the genotypes showed very high sustainability index as expected because quality traits are least affected by the environmental factors.

The comparative study indicated that the genotypes LD 861 and CISA 614 were found stable for seed cotton yield based on the linear component (bi), non-linear response (S^2 di) and high mean performance (x), whereas based on sustainability index and best performance, the only genotype CISA 614 was found to be stable. Thus, it may be concluded that based on Eberhart and Russell model and sustainability index model, the genotype CISA 614 was found most stable for seed cotton yield. For other characters the results were found in conformity based on Eberhart and Russell model and hence the sustainability index model may be used for selecting the stable genotypes, however for 2.5% staple length it was found contrary.

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