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Stability analysis of elite breeding lines of upland cotton (*Gossypium hirsutum* L.) for seed cotton yield and its component traits

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ABSTRACT : The present investigation was carried out by adopting stability analysis for eleven characters in thirty elite breeding lines of upland cotton planted under three environments. The observations were taken at different sowing dates of the genotypes (early, mid late and late) during *kharif*, 2015. The crop was sown in randomized block design with three replications at CCS Haryana Agricultural University, Hisar. The joint regression analysis revealed that the sufficient genetic variability was present among genotypes for monopods/plant, sympods/plant, days to first flower, seed index, lint index, lint yield/plant with highly variable environments chosen for the present study. Furthermore, the genotype x environment interaction was highly significant for monopods/plant, seed index and lint yield/plant. The genotype H 1505 was found to be stable and suitable for all types of environments and also deserves attention of the plant breeders for inclusion in breeding programme as adaptable and stable genotype for seed cotton yield/ plant, respectively.

Key words: Joint regression analysis, stability analysis, upland cotton

Cotton popularly called as "White Gold", is the most important renewable natural fiber crop in the Indian textile scene. It is an important fiber yielding crop of global importance, which is grown in tropical and subtropical regions of more than 80 countries of the world with average productivity of 766 kg/ ha and area of 330 lakh ha (Cotton Advisory Board, 2016-17). Globally during 2016-17, India ranks first in cotton area (10.50 m ha) but occupies second position in production (35.10 million bales), with a productivity of 568 kg/ha and cotton in Haryana was grown in an area of 4.98 lakh ha with a production of 20.00 lakh bales and a productivity of 683 kg/ha (https:// www.cotcorp.gov.in).

It played a triple role by producing lint, oil and protein. Cotton stalks are also used as fuel, for making particle and paper board. The productivity of upland cotton is fluctuating over a wide range of environments. A statistic that fully represents a genotype's stability and yield potential is a measure of genotypes desirability and provides a meaningful selection criterion for plant breeders, geneticists and production agronomists.

Stability analysis helps in understanding the adaptability of crop varieties over a wide range of environmental conditions and identification of the most adaptable genotypes. The use of adaptable genotypes helps in achieving stabilization in crop production. The genotype x environment interaction is the interplay of genetic and non-genetic effects on the phenotypic expression as indicated by the failure of a genotype to give consistent performance in different environments. G x E interaction was observed to be present in pure lines and different types of hybrids irrespective of their genetic composition. Keeping in view the importance of G x E interactions, the research work on the present study was selected with objective to identify the stable genotypes performing uniformly in all the environments.

The present study was conducted for the thirty elite breeding lines/genotypes of upland cotton over different environments with the objective to identify the stable lines/genotypes for seed cotton yield and other component traits. These genotypes were sown under three environments which were created by different dates of sowing *i.e.* early (19th April, 2015), timely (13th May, 2015) and late (24th May, 2015) during *kharif, 2015* in the Research Area of Cotton Section, CCS Haryana Agricultural University, Hisar with 67.5 x 30 cm spacing of row to row and plant to plant, respectively in three replications of randomized block design. Observations were recorded for eleven traits *i.e.* plant height (cm), days to first flower, monopods/ plant, sympods/plant, bolls/plant, boll weight (g), seed index (g), lint index (g), lint yield/plant (g), ginning outturn (%) and seed cotton yield/plant (g). Based on the significance of G x E interactions, the stability parameters S^2di and parameters of response bi were worked out for eleven traits mentioned.

Based on pooled analysis, it was observed that highest mean value (100.33 cm) for plant height and monopods/plant (1.92). Highest range was observed for all the traits in E_1. E_2 had higher range for boll weight, seed index and sympods/ plant in comparison with E_3. E_3 had higher range for most of the traits, *viz.,* plant height, monopods/ plant, bolls/plant, lint index, lint yield/plant, ginning outturn and seed cotton yield/plant but had lower range for days to first flower (desirable earliness) in comparison with E_2 (Table 1).

The study of genotype x environment interactions forms an important aspect of all major breeding programmes. Breeders usually evaluate a large number of genotypes in different locations and take years in order to select the genotypes with high stability for yield, but significant G x E interactions often complicates the breeder to work as yield cannot be predicted in this case.

Significance of G x E interaction mean squares for monopods/plant, seed index and lint yield/plant indicated that genotypes showed

Table 1. Mean and Range for various traits in cotton under different environments

Sr. No.	Traits	E1		E_2		E_3		Pooled	
		Mean	Range	**Mean**	Range	**Mean**	Range	**Mean**	Range
1	Plant height (cm)	122.4	105.0-143.3	84.8	70.0-100.0	93.8	80.0-118.0	100.3	70.0-143.3
2	Monopods/ plant	2.1	1.0-3.3	1.7	1.0-3.0	2.0	1.0-3.0	1.9	1.0-3.3
3	Sympods/ plant	22.6	18.3-24.7	21.0	16.0-24.3	17.0	14.0-21.0	20.2	14.0-24.7
4	Days to first flower	61.0	54.0-69.0	55.8	52.0-61.0	52.5	48.0-60.0	56.5	48.0-69.0
5	Bolls/ plant	31.5	22.0-41.7	21.5	13.7-32.0	23.9	17.0-35.0	25.6	13.7-41.7
6	Boll weight (g)	3.4	2.7-4.1	3.0	2.2-3.9	3.0	2.3-3.4	3.1	2.15-4.12
7	Seed index	6.0	5.2-6.8	5.7	5.1-6.4	5.4	5.0-6.0	5.7	5.0-6.8
8	Lint index	3.8	3.2-4.5	3.1	2.5-3.5	3.2	2.7-3.9	3.3	2.5-4.5
9	Lint yield/ plant (g)	38.4	25.8-52.0	20.8	13.3-31.4	24.4	15.8-35.7	27.8	13.3-52.1
10	Ginning out turn (%)	38.7	35.9-40.7	35.1	32.7-37.3	36.8	34.0-39.1	36.9	32.7-40.7
11	Seed cotton yield/ plant (g)	98.9	68.0-128.5	59.1	39.6-85.1	66.3	44.0-95.0	74.8	39.6-128.5

Table 2. Magnitude (%) of linear and non linear components of G x E interaction

Traits	Linear	Non linear
Plant height (cm)	48.77	51.23
Monopods/plant	77.92	22.08
Sympods /plant	45.75	54.25
Days to first flower	62.21	37.79
Bolls/plant	65.81	34.19
Boll weight (g)	48.00	52.00
Seed index (g)	83.33	16.67
Lint index (g)	39.58	60.42
Lint yield/ plant (g)	71.87	28.13
Ginning outturn (%)	41.71	58.29
Seed cotton yield/plant (g)	68.89	31.11

differential response to the change in environmental conditions. It was further noticed that both linear and non linear components significantly contributed to the total G x E interaction for all the traits (Table 2). For plant height, boll weight, lint index and ginning outturn, only non linear component contributed to G x E interactions, whereas, for monopods/ plant and seed index there was preponderance of linear component of G x E interaction. In an earlier study, Patil and Patel (2010) also reported that substantial portion of the G x E interactions

Table 3. Distribution of different genotypes on the basis of different stability parameters for various traits

Traits	Predictable Genotypes		Unpredictable Genotypes	
	Genotypes for both bi andS^2di non-significant	Genotypes for only bi significant	Genotypes for both bi and S^2di significant	Genotypes for only S^2di significant
Plant height (cm)	28	0	0	2
Monopods/plant	21	8	0	1
Sympods /plant	30	0	0	0
Days to first flower	26	3	0	1
Bolls/plant	22	2	1	5
Boll weight (g)	19	0	0	11
Seed index (g)	27	3	0	0
Lint index (g)	22	0	0	8
Lint yield/ plant (g)	15	2	2	11
Ginning outturn (%)	21	0	0	9
Seed cotton yield/ plant (g)	11	3	1	15

was linear for the sympodia/plant, bolls/plant, boll weight, seed index, lint index and seed cotton yield. Both linear and non linear components were equally important for days to 50 per cent flowering, monopodia/plant and seeds/ boll. Variance due to genotypes, environments and G x E interaction was significant for all traits. Similar results also reported by Satish, *et al.,* 2009 and Dewdar (2013) also observed significant differences among cotton genotypes for seed cotton yield/plant, lint yield/plant, bolls/plant, boll weight, lint per cent and lint index.

Genotype H 1502 was found to be stable and suitable for all types of environments, having b_i value approaching to one for monopods/plant. For bolls/plant only one genotype *i.e.*, H 1505 was having b_i value approaching to one, indicating that these genotypes were suitable for all types of environments. Likewise, optimum test locations were identified for lint yield, lint per cent, strength and UHML and across all test locations in Texas over 2 years suggesting a

Table 4. Selected genotypes having general and specific adaptability for favourable and unfavourable environments

Traits	High mean	Non significant S^2_{di} (stable)	b_i<1 for unfavourable environment	b_i = 1 for general adaptability	b_i >1 for favourable environment
Plant height (cm)	5	4	H 1462, GCA 28, H 1500	-	-
Monopods /plant	13	12	-	H 1502	H 1503, GCA 28, H 1500
Sympods /plant	11	11	H 1492, H 1503, H 1515, CA 3, H 1516	-	-
Days to first flower	14 (early)	14	H 1482, H 1482, H 1513, H 1495, H 1515, GCA 28, H 1500	-	-
Bolls/plant	5	4	H 1491	H 1505	-
Boll weight (g)	6	5	H 1454, H 1511, H 1515	H 1512, H 1499	-
Seed index (g)	12	12	H 1454, H 1505, GCA 3, GCA 28	H 1513	H 1500
Lint index (g)	9	6	H 1454, 15, H 1513, GCA 3, H 1500	-	-
Lint yield/ plant (g)	6	5	H 1491, 10, H 1505	-	-
Ginning outturn (%)	2	1	H 1491	-	-
Seed cotton yield/ plant (g)	5	2	HS 288	H 1505	-

large genotypic component governing those traits reported by Ng *et al.,* 2013.

This was also noticed for boll weight that two genotypes H 1512 and H 1499 were found suitable for all types of environments as they were having b_i values approaching to one. In case of seed index, H 1513 was having b_i value approaching to one (0.746), indicating its suitability for general environment. H 1500 had b_i > 1 (1.312), indicating its suitability for favourable environments. H 1491 was having maximum ginning outturn (mean = 37.758 per cent) followed by H 1499 with mean 37.679 per cent but all genotypes were having b_i < 1, indicating their suitability for poor or unfavourable environments. while Singh *et al.*, 2012 were also observed highly significant mean squares for heterogeneity between regressions for all the traits which indicated that the predictions can be made about the stability of hybrids over the environments and Singh, S. *et al.*, (2014) predicted the genotype x environment mean square was significant for seed cotton yield and fiber strength indicating different response of the genotypes in different environments and for boll weight and seed cotton yield, among the two crosses had high mean and was stable and responsive to favorable environments as indicated by the regression coefficient more than unity.

For seed cotton yield/plant, H 1505 was having highest seed cotton yield/plant (mean= 87.063 g), also b_i approaching to one, indicating its suitability to general environment (Table 4). It is evident from the results presented (Table 3) that majority of genotypes showed below average response to the environments. These results indicated that there was sufficient variation for performance of the genotypes under different environments. This suggested the presence of high genotype x environment interaction for seed cotton yield in upland cotton. For any breeding programme variation in the material is the first requirement. The present study showed that the lots of variation present among the studied genotypes. The ultimate aim of studying the phenotypic stability under the present studies was to find out stable genotypes and which could be exploited further in breeding programmes. Dewdar, (2013) also reported that combined analysis showed highly significant between the genotypes, between environments and for genotype x environment interaction of all traits under study. This implied therefore, that the genotypes were low contribution to the genotypic by environment interaction. The results showed that high yield genotypes could be differed in yield stability and suggest that yield stability and high mean yield are not mutually exclusive. In the present study, the genotype H 1505 was found to be stable and suitable for all types of environments and also deserves attention of the plant breeders for inclusion in breeding programme as adaptable and stable genotype for seed cotton yield.

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