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PHENOTYPIC STABILITY OF SINGLE AND THREE-WAY HYBRIDS OF COTTON

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ABSTRACT

Cytoplasmic-genetic male sterile lines of cotton, were employed to develop 30 hybrids. Thirty hybrids along with four checks were planted in kharif (rainy) season of 1984 in five environments. Stability analysis revealed that mean squares both for genotype × environment (linear) and pooled deviations were significant for seed cotton yield, number of bolls/plant, and average boll weight. Hybrids ICHB 36, ICHB 3, ICHB 10, ICHB 9, and ICH 24 were identified to have average stability for seed cotton yield. Hybrids JKHy 1 and ICHB 11 were suitable for favourable environments. Most of the stable hybrids originated from *hirsutum* × *barbadense* crosses.

Key words: Stability analysis, cotton, three-way crosses, single crosses.

Cotton, an important fibre crop, is grown on about eight million hectares in India. Seed cotton yield is low and fluctuates from location to location and from season to season. It is, therefore, important that genotypes of cotton are identified which manifest relatively less genotype × environment interaction.

MATERIALS AND METHODS

The cytoplasmic-genetic male sterile lines of cotton (CMS Khandwa 2, CMS Reba-B-50, and CMS Bikaneri Nerma), evolved at Indore, were employed as female parents and crossed to three fertility restorers, viz., JPR 1 (*Gossypium barbadense*), JBWIg 221–21 and JBWIg 221–36 (*G. hirsutum*), to produce single-cross hybrids. Simultaneously, 21 three-way hybrids were developed by crossing the fertility restorers to the sterile single crosses. Maintainer of CMS 23 was also used in the development of three-way hybrids. Nine singlecross hybrids, 21 three-way hybrids along with four checks, viz., Hybrid 4, Varalaxmi, JKHy 1 and JKHy 11, were planted in randomized block design with 3 replications in 5 environments in the kharif (rainy) season of 1984 (sowings: Indore on 2.7.1984; Khandwa on 28.6.1984, and Jaora on 3.7.1984). The plot comprised of a single row, 6.3 m long, spaced 90 cm apart. Within the rows, the plant-to-plant distance was 90 cm. The five environments were created by planting the experimental material as rainfed or irrigated at Indore and Khandwa, and irrigated at Jaora. The locations represented two typical agroclimatic regions, Malwa and Nimar of Madhya Pradesh where cotton is widely cultivated. Irrigation was given when necessary. Fertilizer was applied @ 100:50:25 kg/ha N, P, and K, respectively, to the irrigated experiment and @ 60:30:15 kg/ha N, P and K, respectively, to the rainfed experiments.

Observations were recorded on five competitive plants of each hybrid in each replication in all the environments on number of bolls/plant, average boll weight (g), and seed cotton yield per plant (g). Stability analysis was carried out following Eberhart and Russell [1].

RESULTS AND DISCUSSION

After the release of first cotton hybrid (Hybrid 4) in 1970, several cotton hybrids have been evolved and recommended for commercial cultivation. Hybrids are relatively more stable in their performance when grown over several locations and years as compared to inbred lines/varieties. Stability in performance is a valuable attribute in a crop which is grown as rainfed under diverse agroclimatic situations.

The stability analysis revealed that mean squares for genotype × environment (linear) were highly significant for all the characters (Table 1), which suggests that there were significant differences among responses of hybrids to varying environments, measured as regression (b). Mean squares for pooled deviations were significant, thus variation in performance over environments was only partly predictable in nature. Shroff et al. [2] observed that only mean square for pooled deviations was significant.

Table 1. ANOVA for stability of various characters of cotton hybrids (mean squares)

Source	d.f.	Seed cotton yield	Bolls/plant	Boll weight
Hybrids	33	1734.4**	248.4**	2.36**
Environments (linear)	1	942979.0**	38735.2**	13.30**
Hybrids × environments (linear)	33	1059.7**	63.5**	0.07**
Pooled deviations	102	288.1**	18.1**	0.05**
Pooled error	330	13.2	0.4	0.02

*P = 0.05, **P = 0.01.

Hybrid JKHy 1 recorded maximum seed cotton yield per plant (Table 2) and was statistically at par with ICHB 1, ICHB 6, ICHB 3, ICHB 10, ICHB 9, ICHB 11 and ICH 24. The performance of Hybrid 4 and Varalaxmi was poor. The latter was at par with ICHB 4, ICH 27, and ICH 30. Regression coefficients (b) of all the hybrids were significantly different from 0. The b values of ICHB 4, ICHB 5, Varalaxmi, ICH 27 and ICH 28 were significantly lower and those of ICH 11 and JKHy 1 significantly higher than unity.

On the basis of three stability parameters, viz., $\bar{x}$, b and S^2d, hybrids ICHB 6, ICHB 3, ICHB 10, ICHB 9, and ICH 24 could be considered as widely adapted.

Although the mean performance of ICHB 1 was comparable to JKHy 1 and the value of b did not differ significantly from unity, it could not be characterized as widely adapted because the estimate of S^2d was significantly different from 0. Since the regression coefficients of JKHy 1 and ICHB 11 were significantly higher than unity, these hybrids were regarded as having below average stability or as specifically adapted to favourable environments.

Hybrids ICHB 6 had maximum number of bolls/plant but was not significantly superior to ICHB 10 (Table 2). Hybrids ICHB 6, ICHB 10, ICHB 11 and ICH 3 were characterized as stable for this character. ICHB 9 and JKHy 1 had below average stability.

Like boll number, average boll weight is also an important component of seed cotton yield. Among the 34 hybrids, ICH 24 recorded maximum boll weight (Table 2). This hybrid was stable for this character.

Table 2. Stability parameters for three characters of cotton hybrids

Hybrid	Pedigree	Seed cotton yield per plant			Number of bolls/ per plant			Average boll weight		
		x	b	S^2d	$\bar{x}$	b	S^2d	$\bar{x}$	b	S^2d
ICHB 3	(CMS Reba 50 × BN) × JPR 1	145.3	1.11**	484.0	46.9	1.26**	33.0	3.66	0.33	0.00
ICHB 6	(CMS K 2 × JPR 1)	147.0	1.16**	343.4	49.5	1.49**	45.2	3.47	0.79*	0.00
ICHB 9	(CMS BN × RB 50) × JPR 1	139.7	1.21**	213.1	43.3	1.48	2.5	4.16	0.68	0.13
ICHB 10	(CMS BN × JPR 1)	143.7	0.87**	424.3	47.7	0.94**	54.7	3.53	0.54 *	0.01
ICHB 11	(CMS BN × K_2) × JPR 1	136.2	0.68**	712.5	47.2	0.80**	35.7	3.68	0.98*	0.00
ICH 24	(CMS RB 50 × GS 23) × JBWIg 221–36	134.3	1.21**	341.6	35.4	1.05**	23.4	5.45	1.20**	−0.01
JKHy	(K_2 MB × RB 50)	155.1	1.39**	0.7	38.1	1.19**	0.3	4.87	2.31	0.14
CD 5%		23.5			5.9			0.3		

*, **Significantly different from 0 at 5% and 1% levels, respectively.

While breeding for high yield, the breeder aims to develop varieties relatively stable over a wide range of environments. According to Grafius [3], such a universal variety must either resist change or adjust favourably to a new environment. The present investigation shows that ICHB 6, ICHB 10 and ICH 24 were not only phenotypically stable for seed cotton yield but also for the two yield components, i.e. number of bolls/plant and average boll weight.

Hybrids JKHy 1 and ICHB 11 were identified as specially adapted to favourable environments.

In the opinion of Allard and Bradshaw [4], a variety can attain phenotypic stability either through individual or populational buffering. Sprague and Federer [5] and Eberhart and Russell [6] demonstrated that double-cross hybrids of maize were more stable in performance when grown over several environments as compared to single-cross hybrids. Jones [7] attributed this stability to the buffering effect of heterogeneity and suggested that it is the stability that enables the double-cross hybrids to record high mean yields over many years, even though highest yield at a particular location and in a particular year is likely to be obtained from a certain single cross. Such a phenomenon could not be verified in the present case. This investigation could not distinguish clearly between single-cross and three-way hybrids with respect to their superiority in stability of performance. However, since three hybrids (ICHB 3, ICHB 9, and ICH 24), out of five hybrids, characterized as stable for seed cotton yield, were three-way hybrids, there is a reason to believe that populational buffering may have an edge over individual buffering in imparting stability of performance. Interestingly, all the stable hybrids, except ICH 24, were *hirsutum* × *barbadense* involving JPR 1 as restorer parent. Hybrid ICH 24, was, however, of *hirsutum* × *hirsutum* origin.

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