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Short Communication

Stability analysis for grain yield in *rabi* sorghum [*Sorghum bicolor* (L.) Moench.]

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Assessment of the stability of a genotype under different environments is useful for recommending cultivars for known conditions of cultivation [1]. Rabi sorghums [*Sorghum bicolor* (L.) Moench.] in India are grown under varied edaphic and environmental conditions and they are known to exhibit high degree of genotype and environmental interaction. Rabi sorghums are very crucial for food and fodder security in the drought prone areas of Maharashtra, Karnataka and Andhra Pradesh [2] as there is no alternative remunerative cereal which can be grown during this season, which receives only 8% of the annual rainfall [3]. In Maharashtra, 75% of total cultivated area in rabi is under sorghum which indicates its relative importance. Though efforts have been made to develop hybrids with wider adaptability to varied production environments (Shallow to medium soils, Deep soils and Irrigated conditions), the efforts have not been successful so far. To elevate the productivity, there is a requirement to develop and identify high yielding hybrids, which are adapted well to production environments of rabi sorghum. Blum [4] discussed limitations in using hybrid *per se* as a selection criterion based on the large effect of environments. Hence there is an urgent need to develop hybrids with suitable performance over a wide range of environmental conditions. For this information on stability of newly developed hybrids is quite important. The present study attempts to analyse the stability of newly bred hybrids of different sorghum breeding centers of All India Coordinated Sorghum Improvement Project.

Twenty-two rabi sorghum hybrids including two standard checks CSH 15R and CSH 19R, and a popular variety M35-1 were evaluated in a randomized block design with three replications at 16 locations spread across rabi sorghum growing regions of Maharashtra, Karnataka, Andhra Pradesh and Gujarat during rabi season of 2000-01 under All India Coordinated Sorghum Improvement Project. The locations represented deep soils (>90 cm soil depth; 9 locations- Rahuri, solapur, Dharwad, Bijapur, Annigeri, Raichur, Tandur, Tancha and Bellary), shallow soils (< 45 cm soil depth; 3 locations- Chas, Solapur and Bijapur) and irrigated soils (deep soil with irrigation; 4 locations- Parbhani, Rahuri, Auragabad and Jalna). The deep and shallow soil environments were rainfed. The recommended dose of fertilizer was uniformly given at the different locations. Minimum plant protection measures were adopted. The grain yield (kg/ha) recorded at maturity was used for stability analysis following Eberhart and Russel model [5].

Pooled analysis (Table 1) indicated significant differences among hybrids for grain yield revealing the presence of sufficient variability in the material. Significant mean squares due to genotype x environment (G $\times$ E) interactions indicated that the genotypes interacted considerably with the environmental conditions. Significant genotypic interaction with environments was reported earlier [6-7]. Both linear and nonlinear components of G $\times$ E interactions were significant showing the importance of both linear and non-linear components in the expression of the traits. The linear component was significant as against the nonlinear component (pooled deviation), which revealed that a large portion of G $\times$ E interaction was accounted for by the linear regression although pooled deviation was significant. The predominance of linear component which was noticed would help in predicting the performance of hybrids across environments.

Production environments differed significantly among themselves as indicated by highly significant environment (linear) component. The locations Solapur, Dharward, Annegiri and Tandur under deep soils; and Parbhani, Rahuri, Aurangabad and Jalna under irrigated conditions were found to be favourable locations. However, all the 3 shallow soil locations *viz.*, Chas, Solapur and Bijapur were unfavorable.

Estimates of stability parameters *viz.*, mean performance, regression coefficient (bi) and deviation from regression (S^2di) of 22 genotypes for grain yield

Table 1. Analysis of variance - stratified environments and pooled

Source	Deep		Irrigated		Shallow		Pooled	
	df	Mean square	df	Mean square	df	Mean square	df	Mean square
Genotypes (G)	21	1105010**++	21	2679149++	21	65172**	21	2579666**++
Environment (E)	8	41390828**++	3	28116280**++	2	4950392**++	15	49186403**++
G × E	168	279383**	63	572178++	42	106354**	315	362264**+
Environment (linear)	1	331126628**++	1	84348841**++	1	9900784**++	1	737796055**++
G × E (linear)	21	676509**++	21	443632++	21	67795**	21	1069339**++
Pooled deviation	154	212531**	44	84045	22	138327**	308	297588**
Pooled error	378	43011	168	23030554	126	9343	672	46957

** and * Significant at 1 and 5% levels against pooled error. ++ and + significant at 1 and 5% levels against pooled deviation

Table 2. Pooled estimates of stability parameters for sorghum

Hybrid	Mean (kg/ha)	bi	S^2di
SPH 1077	2734.00	1.07+	2853.06*
SPH 1078	2563.00	1.03+	9112.03 *
SPH 1079	2920.00	1.05+	7707.06*
CSH 15R	2469.00	0.95+	1642.13
SPH 1089	2884.00	1.12+	9397.50*
SPH 1174	2687.00	1.07+	6736.25*
SPH 1219	2659.00	1.02+	2891.34*
SPH 1221	2748.00	1.27+	2370.43*
SPH 1225	3169.00	1.17+	5303.78*
SPH 1226	2007.00	0.59+#	5392.54*
SPH 1227	2123.00	0.86+	8919.32*
CSH 19R	3238.00	1.24+#	9995.14
SPH 1229	2649.00	1.1+	8838.10*
SPH 1230	2516.00	0.87+	1398.31*
SPH 1231	2804.00	1.05+	5206.27*
SPH 1233	2855.00	1.11+	7165.14*
SPH 1234	2825.00	1.02+	6292.21*
M35-1	2336.00	0.83+#	4208.32*
SPH 1235	2102.00	0.85+	4730.90*
SPH 1236	2710.00	1.09+	6626.90*
SPH 1237	2644.00	0.99+	9593.43*
SPH 1238	1449.00	0.56+#	2855.56*
Mean	2595.05	1.00	
CD at 5%	275		

+ Significantly different from 0 and equal to 1; =# Significantly different from 0 and 1; *Significant at 5% level

are presented in Table 2. Simultaneous consideration of the three parameters revealed that, out of the 22 genotypes tested, only one hybrid, CSH 15R which is released for rabi sorghum cultivation was found to be highly stable across all the environments. Wider adaptability of CSH 15R was reported by Narkhede *et al.* [8]. This hybrid showed unit regression, non-significant deviation from regression and good grain yield. On the other hand, the hybrid CSH 19R, released recently for rabi season, was found to be unstable but highly suitable for favorable locations as displayed by bi > 1 and non-significant S^2di. None of the newly bred hybrids were found to be widely adaptable to all the production environments.

Thus the present investigation revealed that the genotype CSH 15R was found suitable for general cultivation while CSH 19R was found to be an ideal hybrid for favorable locations. The variety M35-1 was however, found to be unstable in its performance across the three production environments.

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