

Stability of Grain Yield and Productivity Traits of A, B and R-Lines of Some Commercial Hybrids Over Different Growing Periods

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Abstract The phenotypic stability of eighteen sorghum [*Sorghum bicolor* (L.) Moench] genotypes (parental lines) was studied for grain yield and productivity traits during different growing seasons viz., *kharif* 2012, late *kharif* 2012, early *rabi*-2012, *rabi*-2012-13. The mean sum of squares for genotypes were significant for plant height at physiological maturity, 100-seed weight, grain yield/plant, dry stover yield per plant and harvest index revealing genetic variability among the genotypes for these traits. The geno-

type \times environment interactions for grain yield, dry stover yield, plant height and days to physiological maturity was significant. The significant mean square due to environment (linear) indicated existence of varietal differences. Among the genotypes, RS673 produced the highest yield which was followed by the genotypes 296A and B. Considering all stability parameters, C43, 27A and B and AKMS14B exhibited above average stability for grain yield/ha. Genotypes 27A and B and C43 showed wider stability for fodder yield/ha, hence, it can be exploited for both grain and fodder purpose.

Keywords G \times E interaction, Sorghum, Stability.

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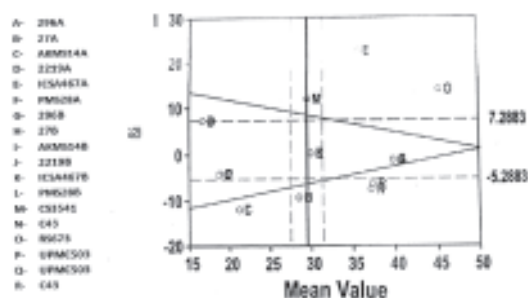
Introduction

Sorghum is an important crop of the South Gujarat. It is popularly grown in the states of Andhra Pradesh, Karnataka, Maharashtra, Tamil Nadu. In India, the area under sorghum is 3.01 million ha with a production of 3.22 million tonnes. The productivity is at 1,071 kg/ha [1]. In Gujarat, area, production and productivity is 1.25 lakh hectares, 1.39 lakh tonnes and 1,105 kg/ha, respectively. The relative performance of cultivars for quantitative traits such as yield and the other characters, which influence yield vary from an environment to another. Consequently, to develop a variety with high yielding ability and consistency, high attention

Table 1. Mean performance of genotypes for yield and productivity traits in sorghum.

Variety	DFE	PHT	HSW	GYPP	FYP	HI
296A	75.00	103.8	2.64	39.70	46.18	46.68
27A	72.50	111.4	2.29	28.54	41.47	40.78
AKMS14A	70.58	103.9	2.51	21.19	50.87	29.09
2219A	70.41	89.6	2.04	16.64	42.33	28.89
ICSA467A	72.08	126.8	2.63	29.93	50.67	37.59
PMS28A	74.41	125.6	2.80	35.65	57.71	38.88
296B	73.41	106.6	2.64	39.70	44.67	47.57
27B	70.75	122.3	2.29	28.54	43.33	39.88
AKMS14B	70.75	105.1	2.50	21.19	37.27	36.52
2219B	69.83	89.8	2.04	16.64	41.35	28.76
ICSA467B	70.25	130.0	2.64	29.93	50.27	37.85
PMS28B	74.91	129.9	2.80	35.65	49.51	41.79
CS3541	71.83	121.2	3.12	29.52	49.85	37.36
C43	72.25	111.6	2.86	37.17	59.04	38.91
RS673	73.33	129.9	2.76	45.18	51.21	48.24
UPMC503	72.58	183.3	2.54	18.86	69.29	21.57
UPMC503	72.25	183.3	2.35	18.65	69.08	21.67
C43	72.08	111.8	2.84	37.34	59.27	38.94
Population mean	72.18	121.4	2.57	29.45	50.74	36.72
SE	2.20	6.4	0.13	1.93	6.51	3.24
CD ($p=0.05$)	2.58	7.44	0.15	2.26	7.62	3.79

should be given to the importance of stability performance for the genotypes under different environments and their interactions. The interaction between genotype and environment had an important bearing on breeding for better varieties buffering [2]. Exploitation of genetic variability is an important tool in plant breeding for sorghum genotypes which has to be inferred by phenotypic expression. The consequences of the phenotypic variations depend largely on environmental changes; these variations are further complicated by the fact that all genotypes don't respond similarly to environmental changes. Analysis of variance estimates the existence, significance and magnitude of GE interaction but does not explain the importance and implications. Thus, statistical models had been developed to decrease GE interaction, magnitude, patterns and implications. Regression analysis is an important biometrical method for measuring the genotypic response for varying environmental condition Eberhart and Russel [3] suggested that the regression coefficient (b) and deviation from regression (S^2d) may be considered as two parameters for measuring the varietal phenotypic sta-

**Fig. 1.** Relationship of grain yield with regression coefficient.

bility. The variety with (b) value did not significantly differ from unity ($b=1$) and (S^2d) did not significantly differ from zero could be described as a stable variety. The objective of present investigation was to study the performance and stability analysis of grain yield in sorghum hybrid parents, tested at four environments (different growing periods of one month interval).

Materials and Methods

The field experiment was undertaken at the College Farm, NM College of Agriculture, Navsari Agricultural University, Navsari (Gujarat), India. Eighteen sorghum lines, viz., 296A and B, 27A and B, AKMS14A and B, 2219A and B, ICSA467A and B, PMS28A and B, CS3541, C43, RS673, UPMC503, UPMC503 and C43 were evaluated in randomized block design (RBD) with three replications. The seeds were dibbled at a spacing of 45 cm \times 10 cm and the recom-

Table 2. Estimates of environmental indices for each character under different environment. E_1 =kharif, E_2 =late kharif, E_3 =mid season, E_4 =rabi.

Characters	Environments			
	E_1	E_2	E_3	E_4
Days to 50% flowering (DFE)	-6.903	2.968	0.745	3.190
Plant height (cm)	16.223	11.060	-2.327	-24.956
100-seed weight (g)	0.029	0.128	-0.076	-0.081
Grain yield/plant (g)	-0.428	0.109	0.298	0.021
Fodder yield/plant (g)	-0.595	-0.932	-4.011	5.537
Harvest index	-0.289	0.332	2.247	-2.291

Table 3. Mean performance and stability parameters for different yield and productivity traits in *rabi* sorghum. ** $p=0.05$, * $p=0.01$, bi =regression coefficient, S^2di =deviation from regression coefficient.

Variety	Days to 50% flowering			Plant height (cm)			100-seed weight (g)		
	Mean	bi	S^2di	Mean	Bi	S^2di	Mean	bi	S^2di
296A	75.00	1.20	0.38	103.8	1.17	-17.2	2.64	0.59	0.04*
27A	72.50	1.32	0.49	111.4	1.37	154.2**	2.29	1.58	0.02
AKMS14A	70.58	0.99	35.00	103.9	0.74	186.0**	2.51	0.78	0.12**
2219A	70.41	0.75	6.43**	89.6	0.68	66.7*	2.04	1.81	0.05*
ICSA467A	72.08	1.29	8.19**	126.8	1.18	168.5**	2.63	0.78	0.01
PMS28A	74.41	1.03	21.16**	125.6	1.66	385.1**	2.80	-0.04	-0.01
296B	73.41	1.24	10.85**	106.6	1.06	-17.2	2.64	0.59	0.04*
27B	70.75	1.13	8.48**	122.3	1.48	11.9	2.29	1.58	0.02
AKMS14B	70.75	1.00	2.34*	105.1	0.63	-14.4	2.50	0.78	0.12**
2219B	69.83	0.84	0.64	89.8	0.74	-17.1	2.04	1.81	0.05*
ICSA467B	70.25	0.97	9.22**	130.0	1.26	-13.9	2.64	0.78	0.01
PMS28B	74.91	0.96	25.86**	129.9	1.40	414.5**	2.80	-0.04	-0.01
CS3541	71.83	0.46	6.28**	121.2	0.76	19.0	3.12	-0.31	0.06**
C43	72.25	0.58	6.09**	111.6	0.03*	18.5	2.86	1.93	0.01
RS673	73.33	0.85	51.97**	129.9	0.74	175.9**	2.76	-0.42	0.00
UPMC503	72.58	1.36	21.88**	183.3	1.50	57.5	2.54	3.05	0.03
UPMC503	72.25	1.37	22.86**	183.3	1.51	61.7*	2.35	1.03	0.05*
C43	72.08	0.61	4.38**	111.8	0.04*	16.7	2.84	1.69	0.00
Population mean	72.18			121.4			2.57		
SE	2.20	0.46		6.4	0.3		0.13	1.32	

mended agronomic practices for the region were followed to ensure healthy crop growth. Five plants were randomly selected from each plot for recording data on plant height (cm), 100 grain weight (g) and grain yield/plant (g). The traits such as days to 50% flowering, grain and dry stover yield/plant (g) were recorded from each plot. The harvest index was calculated as: $HI=GY/BY$ Where, HI =Harvest index, GY =Grain yield, BY = Biological yield. The phenotypic stability parameters; regression coefficients (b_1) and mean square deviations from regression (S^2di) were calculated using the model described by Eberhart and Russell [3].

Results and Discussion

The analysis of variance showed that the mean differences among the genotypes were highly significant for days to 50% flowering, 100-seed weight, grain yield/plant, fodder yield/ha and harvest index revealing genetic variability among genotypes for these traits. Analysis of variance also revealed significant difference among environments for all the characters indicating adequate heterogeneity of environments

and their suitability for evaluating the genotypes. The mean sum of squares due to genotypes \times environment was significant for days to 50% flowering, plant height, grain yield/plant and grain yield/ha when tested against pooled error indicating that the genotypes interacted strongly with the environment for these traits. Similar results were reported by Prabhakar and Patil [4], Menshawi [5], Ezzat et al. [6] and Prabhakar et al. [7].

Variance due to $G \times E$ (L) were significant for all the traits except plant height, fodder yield and harvest index indicating presence of genetic differences among varieties for their regression on environmental indices. The results are in agreement with the finding of Shah and Sharma [8] for test weight and Prabhakar et al. [7] for days to flowering and grain and fodder yield.

The magnitude of linear component (genotype \times environment) was more than non-linear component (pooled deviation) for all the characters except grain yield and harvest index indicating its major role in the expression of these traits and the performance of the

Table 4. Mean performance and stability parameters for different yield and productivity traits in *rabi* sorghum. ** $p=0.05$, * $p=0.01$, bi =regression coefficient, S^2di =deviation from regression coefficient.

Variety	Grain yield/plant (g)			Fodder yield/plant (g)			Harvest index		
	Mean	bi	S^2di	Mean	Bi	S^2di	Mean	bi	S^2di
296A	39.70	-1.23	6.62	46.18	-0.35	151.98**	46.68	0.22	24.89**
27A	28.54	-9.31*	-3.74	41.47	-0.29	-2.25	40.78	-0.95*	-1.66
AKMS14A	21.19	-11.98	18.04*	50.87	-0.64	72.27**	29.09	-0.67	9.11**
2219A	16.64	7.22	3.62	42.33	-0.28	185.91**	28.89	1.42	66.17**
ICSA467A	29.93	0.21	10.85	50.67	-0.07	154.75**	37.59	-1.01	45.80**
PMS28A	35.65	22.49	2.87	57.71	-3.11	385.17**	38.88	-1.89	53.20**
296B	39.70	-1.23	6.62	44.67	0.72	154.27**	47.57	1.66	24.18**
27B	28.54	-9.31*	-3.74	43.33	1.47	8.46	39.88	1.24	-0.62
AKMS14B	21.19	-11.98	18.04*	37.27	2.51*	-7.58	36.52	2.51	71.36**
2219B	16.64	7.22	3.62	41.35	-0.17	40.76*	28.76	1.10	44.09**
ICSA467B	29.93	0.21	10.85	50.27	2.14	81.27**	37.85	2.26	20.83**
PMS28B	35.65	22.49	2.87	49.51	1.90	15.16	41.79	2.54	30.97**
CS3541	29.52	11.84	33.23**	49.85	2.00	83.33	37.36	1.31	42.72**
C43	37.17	-7.61*	-5.07	59.04	2.14	30.09	38.91	1.79	-1.41
RS673	45.18	13.77	6.14	51.21	4.02	183.82**	48.24	4.59	59.53**
UPMC503	18.86	-4.11	-0.53	69.29	1.92	248.79**	21.57	0.08	21.77**
UPMC503	18.65	-4.23	-0.08	69.08	1.93	246.13**	21.67	0.09	22.18**
C43	37.34	-6.47*	-4.94	59.27	2.14	29.64*	38.94	1.69	-1.18
Population mean	29.45			50.74			36.72		
SE	1.93	6.29		6.51	1.63		3.24	1.73	

genotypes for these traits may be predicted across the environments with great precision. Variances due to pooled deviation were significant for all the traits.

The mean performance of genotypes is presented in Table 1. The days after sowing to 50% flowering ranged from 69.83 in 2219B to 75 in 296A. Among the genotypes, highest plant height was obtained in UPMC503 (183.3 cm), while lowest (89.6 cm) in 2219A. The 100-seed weight ranged from 2.04 (g) in 2219A and B to 3.12 (g) in CS3541. However, genotype RS673 recorded highest grain yield/plant (45.18 g) while lowest (16.64 g) in 2219A and B. The genotype UPMC503 registered highest fodder yield (69.29 g) and which was lowest in AKMS14B (37.27 g). The harvest index ranged from 21.57 in UPMC503 to 48.24 in RS673. However, genotype UPMC503 (69.29 g) gave significantly highest fodder yield followed by UPMC503 (69.08 g). The highest grain yield of genotype RS673 (45.18 g) was recorded due to short plant height (129.9 cm) among all the genotypes followed by highest harvest index (48.24). Higher values of harvest index (HI) indicated that more dry matter was translocated from leaf and stem to grain in RS673. The results ob-

tained are in agreement with the findings of Parameshwarappa and Dhanaleppagol [9] for earliness, Deepalakshmi and Ganesamurthy [10] for plant height, Tariq et al. [11] and Kumar et al. [12] for harvest index and Mahajan et al. [13] for earliness and harvest index.

The estimates of environmental indices (Table 2) expressed as deviation from grand mean indicated that mid season ($E_3 = 0.298$) was the most favorable for grain yield/plant and harvest index (2.247). However, *rabi* season was favorable for fodder yield/plant (5.537), and days to 50% flowering (3.190), while, *kharif* season was favorable for plant height (16.223) and late *kharif* for 100-seed weight (0.128). The stability parameters for various characters are presented in Tables 3 and 4. The genotypes, 296A, 2219A, ICSA467A, PMS28A 296B, 2219B, ICSA467B, PMS28B, UPMC503, RS673 and UPMC503 recorded higher grain yield/plant than population mean, higher magnitude (more than unity), regression coefficient (bi) and non-significant S^2di , indicated better adaptability these characters to environmental changes. However, genotype 27A and B and C43 were found to

be suitable for adaptation to the changes in environment (below average stability) as it recorded bi value as significantly higher than unity, higher mean grain yield/plant and non-significant S^2di (Fig. 1). Suggested that the yield was dependent on environment and the stable lines identified by him for all environment supports present finding for grain yield.

The genotypes, 27A and B, PMS28B, C43 and CS3541 recorded higher mean fodder yield/plant than population mean with $bi \approx 1$ and non-significant S^2di revealing good stability. However, AKMS14B was found to be suitable for favorable environment and genotypes, viz., 296A, 2219A, AKMS14A, ICSA467A, PMS28A, 296B, 2219B, ICSA467B, RS673, UPMC503, C43 and UPMC503 showed non-linear component which was significant for fodder yield/plant and recorded unpredictable behavior.

From the present study, it is concluded that the genotype RS673 recorded highest grain yield due to short plant height with high harvest index. These two traits exerted greatest influence on grain yield, and those were considered as important components in sorghum. The genotype RS673 was found to be adaptable for favorable environmental conditions for grain yield/plant.

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