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Identification of stable morphological and anatomical characters of sorghum [*Sorghum bicolor* (L.) Moench] stalk

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Many morphological and anatomical characters of sorghum-stalk are associated with lodging and plants ability to withstand invasion of stalk-rot pathogens [1]. Morphological characters namely, plant height [2] and stalk diameter [3] and anatomical characters namely, number of vascular bundle and positioning of vascular bundle in stalk play significant role in determining stalk strength, lodging resistance [4] and charcoal rot intensity [5] in sorghum. It is, therefore, important to know the stability in performance of rabi sorghum genotypes for the above characters. The present study deals with the stability analyses of morphological and anatomical characters of sorghum-stalk for eight genotypes of rabi sorghum grown under three environments.

The study was conducted with eight sorghum genotypes (M35-1, E36-1, CSV8R, CSV-14R, Sel-3, LG146, R2270 and CSH15R) in the experimental field of Centre on Rabi Sorghum, Solapur, Maharashtra during consecutive 3 winter seasons (2000, 2001 and 2002). The experiment was laid out in randomized block design with three replications. Plot size was 5 $\times$ 2.7 m^2 and spacing was 45 $\times$ 15 cm^2. The crop was grown following standard recommended package of practices under protective irrigation. Observations were recorded on randomly selected 10 plants in each plot at flowering stage for stalk diameter, plant height, vascular bundle number and vascular bundle density at various positions (peripheral and overall) of the stalk. Vascular bundle number and density were recorded by microscopic (Magnus, MRX) observation of a thin transverse section from second inter-node of stalk. In sorghum, vascular bundles are closely placed towards periphery and sparse at the central cortex. Therefore, vascular bundle number and density were separately calculated for peripheral region and for overall stalk region. To make study convenient 1 mm thick outermost region of transverse section of stalk was considered as peripheral region of the stalk. Data were analyzed using the method of Eberhart and Russell [6].

Pooled analysis (Table 1) revealed significant differences among genotypes and environments for all the characters except vascular bundle number (peripheral and overall) and plant height. Genotypes showed different performances over different environments for all the characters except vascular bundle number (peripheral and overall). The significance of Environments (linear) for all the characters except vascular bundle number (peripheral and overall) revealed the existence of real varietal differences for regression over environmental means. The significance of pooled deviation for all the characters except vascular bundle density (peripheral and overall) showed that the G $\times$ E interactions of the genotypes was unpredictable for these characters.

Various workers have used different measures of stability. Earlier, Finlay and Wilkinson [7] considered linear regression slope as a measure of stability. In judging the stability of genotypes, Eberhart and Russell [6] emphasized the need of considering both linear (bi) and non-linear (S^2di) components of G $\times$ E interactions. In the present study, the stability of genotypes to various morphological and anatomical characters of sorghum stalk was judged on the basis of deviation from the regression line (S^2di) and due consideration was also given to their mean performance and linear response. All the genotypes showed non-significant mean square deviation from regression for the characters *viz.*, stalk diameter and vascular bundle density (peripheral and overall) (Table 2). This indicated that the performance of the genotypes over environments for these characters is predictable. It means all the genotypes exhibited stable reaction for these characters. On the contrary, the significant S^2di values for vascular bundle number (periphery and overall) and plant height indicated that the performance of the genotypes over environments was unpredictable for these traits. There was no stable reaction for these characters by genotypes and they were more vulnerable to environments. As the G $\times$ E (linear) was non-significant, there was no variation for the bi values for vascular bundle number (peripheral and overall). It is inferred that the character vascular bundle density (overall) was identified as the

Table 1. Anova for stability of morphological and anatomical characters of sorghum stalk

S.No.	Components	df	Mean sum of squares					
			Stalk dia (mm)	Plant height (cm)	Vascular bundle No. (periphery)	Vascular bundle No. (overall)	Vascular bundle density (No./mm^2) (periphery)	Vascular bundle density (No./mm^2) (overall)
1.	Genotypes	7	3.76**	384.2**	1226.19	2030.54	3.63**	1.52**
2.	Environments	2	12.31**	2932.0**	940.25	2785.00	3.09**	3.54**
3.	G×E	14	1.09	75.9	683.95	1324.96	0.35	0.22
4.	Environment + (G×E)	16	2.49	432.9**	716.01	1507.47	0.69	0.64
5.	Environment (linear)	1	24.61**	5863.1**	1880.15	2270.70	6.17**	0.78**
6.	G × E (linear)	7	1.14	62.2	661.56	1082.64	0.38	0.15
7.	Pooled deviation	8	0.91*	78.4*	618.11*	1371.33**	0.27	0.26
8.	Pooled error	42	1.15	102.2	700.65	934.69	0.81	0.49

*, ** = Significant at 5% and 1%, respectively against pooled error

Table 2. Stability parameters for morphological and anatomical characters of sorghum stalk

Genotypes	Stalk diameter (mm)			Plant height (cm)			Vascular bundle No. (periphery)			Vascular bundle No. (overall)			Vascular bundle density (No./mm^2) (pheriphery)			Vascular bundle density (No./mm^2) (overall)		
	X	bi	S^2di	X	bi	S^2di	X	bi	S^2di	X	bi	S^2di	X	bi	S^2di	X	bi	S^2di
LG146	10.3	0.75	0.14	106.4	0.74	11.4*	246.2	−0.24	66.3*	354.4	0.36	250.9*	8.4	1.40	0.05	4.3	1.08	0.01
E36-1	10.5	0.68	0.31	101.8	0.85	41.3*	271.6	−0.47	353.6*	380.2	0.28*	3114.2*	9.3	1.77	0.27	4.6	1.43	0.29
Sel-3	11.3	1.28	0.72	135.0	0.52	35.5*	219.3	−0.29	8.9*	320.0	−0.52	171.8*	6.9	1.57*	0.93	3.4	1.02	0.73
R2270	10.5	0.39	0.85	119.2	1.36	340.9*	241.3	−0.52	288.6*	346.0	0.56*	1483.7*	8.2	1.65	0.65	4.1	1.32	0.64
M35-1	12.0	0.31*	3.56	122.9	1.01	28.8*	234.1	1.90*	1664.7*	352.2	2.38*	1498.9*	6.3	0.37	0.10	2.8	0.08	0.07
CSV8R	11.2	0.95	0.58	102.9	1.29	0.4*	208.4	0.99*	464.7*	315.1	0.83	604.2*	6.6	0.51	0.01	3.3	0.92	0.08
CSV14R	12.2	1.57	0.04	119.6	1.23	21.3*	225.6	2.67	2.8*	336.0	2.57	451.1*	6.7	0.87	0.01	3.0	1.15	0.13
CSH15R	13.2	2.09	1.10	116.1	1.00	149.4*	254.4	3.87*	2.1	388.4	2.26*	3395.4*	6.5	−0.14	0.15	2.9	0.99	0.10
X	11.5			115.5			237.7			349.1			7.4			3.6		
SE±	0.68			0.63			17.58			26.19			0.4			0.4		

*, ** = Significant at 5% and 1%, respectively

only anatomical character which can be considered to be stable and hence, reliable for assessing the genotype. This is supported by the non-significant pooled deviation. However, stalk diameter can also be taken as stable since the genotypes showed non-significant mean square deviation. As the objective of the study is to identify the stable traits for assessing the genotypes, importance is given to the anatomical characters. Among the genotypes studied, CSV-8R showed stable reaction to the character namely stalk diameter and LG146, Sel-3, CSV8R, CSH15R for vascular bundle density (overall). None of the genotypes expressed any stable reaction to vascular bundle density (peripheral). The genotype M35-1 alone showed significant bi values for stalk diameter and Sel-3 for vascular bundle density (periphery). Considering the mean performance of genotypes, CSH-15R, CSV-14R, Sel.3 and CSV-8R exhibited higher mean values for stalk diameter, whereas genotypes E36-1, LG-146 and R2270 for vascular bundle density (periphery and overall).

Hence, it is concluded that the anatomical characters vascular bundle density and stalk diameter may be considered for assessing the genotypes to determine stalk strength, lodging resistance and charcoal rot intensity in sorghum, as they showed stable reaction over environments. The performance of genotypes over environments for the remaining characters was highly unpredictable and differed with environments.

References

1. **Maranville J. W. and Clegg M. D.** 1984. Morphological and physiological factors associated with stalk strength. *In*: Sorghum Root and Stalk Rots, A Critical Review, Mughogho L. K. and Rosenberg (Eds). ICRIS, pp 111-118.
2. **Bash Ford L. L., Maranville J. W., Weeks S. A. and Campbell R.** 1976. Mechanical properties affecting lodging of sorghum. Transactions of the American Society of Agricultural Engineers, **19**: 962-966.
3. **Esechie H. A., Maranville J. W. and Ross W. M.** 1977. Relationship of stalk morphology and chemical composition to lodging resistance in sorghum. Crop Science, **17**: 609-612.
4. **Hamilton D. G.** 1951. Culm, crown and root development in oats as related to lodging. Science of Agriculture, **31**: 286-315.
5. **Das I. K. and Patil K. D.** 2001. Anatomical attributes of sorghum [*Sorghum bicolor* (L.) Moench] stalk and their relation with internal spread of charcoal rot. Proc. National Seminar on Emerging Trends in Pests and Diseases and their Management. Tamilnadu Agricultural University, Coimbatore, Oct. 11-13, 2001. Abstr. 113p.
6. **Eberhart S. A. and Russel W. A.** 1966. Stability parameters for comparing varieties. Crop Science, **6**: 36-40.
7. **Finlay K. W. and Wilkinson G. N.** 1963. The analysis of adoption in plant breeding programme. Australian Journal of Agricultural Research, **14**: 742-754.