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Research Paper

Stability analysis for green fodder yield and its component traits in sorghum [*Sorghum bicolor* (L.) Moench]

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ABSTRACT

Sorghum is an important fodder crop. Pooled results showed that genotypic variance when tested against G x E were significant for all the traits under study. However, when tested against pooled deviation these variance revealed significant difference for all the traits except number of tillers per plant, leaf : stem ratio, and HCN content. Environment variances were significant for all the traits. Partition of G x E interaction showed that pooled deviation effect was significant for all the traits except number of leaves per plant, crude protein yield per plant. G x E (linear) was significant for leaf length, leaf width. Stem thickness, green fodder yield per plant, dry matter yield per plant, crude protein content, crude protein yield per plant when tested against pooled deviation. Among the parents Indore 9A form female and HC 308 and PB 181 from male were stable under better environment where as S 1049, and IS 2472 adopted under poor environment. Among hybrids, Indore 9A x ASFS 7, Indore 9A x IS 21475. Indore 9A x PB 22 were found stable under better environment whereas, 3660 A x PB 78 and 3660 A x PB 181 were found suitable for poor environment.

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Key words : Sorghum, Stability, Environment, Hybrid

INTRODUCTION

Sorghum [S*orghum bicolor* (L.) Moench] rank first among the cereal fodder crops because of its growing ability in poor soil, fast growth habit, high yield, palatable and nutritious quality. It gives almost uniform green fodder yield throughout the year. It is an important fodder crop of dry land agriculture and locally known as Jowar. It is highly necessary to develop a high yielding hybrid which can withstand under changing environmental condition. Present green fodder availability is 224.08 million tones against demand of 611.99 million tones which showed 63.38% deficit (Appaji *et al*., 2003).

Phenotype is defined as a linear function of genotype (G), environment (E), and G x E interaction effects. Relative importance of main and interaction effects may vary from genotype to genotype and with environment. The study G x E interaction serves as a guide for various environmental niches. It is possible to identify genotypes that have stability for high yields. It has been suggested by many workers that stability is a genetical characters (Bains and Gupta, 1974 and Cross, 1977). Stability of yield may be dependant upon stability for yield components. Paroda and Hayes (1971) suggested that the linear regression (bi) could simply be regarded as a measure of response of a particular genotype where as deviation from regression (s^2di) should be considered as a measure of stability.

MATERIALS AND METHODS

The experimental material comprised of three male sterile lines as a female parents and sixteen genotypes used as a male parent. These females and males were crossed in a line x tester mating system. In *Kharif* 2005-06, the seeds of 48 F_1 were prepared by hand pollination. The experiment was laid out in Randomized Block Design with three replications, over three environments created by different date of sowing *viz*., 15th June, 1st August and 15th September, 2005 at Plant Breeding Farm, Anand Agricultural University, Anand. Each net plot had single row of 4.5 m each, the inter row spacing being 30 cm apart. The border rows were provided all around each replication. The crop was raised as per recommended package of practices. Five competitive plants were selected at random from each plot and tagged. The observations were recorded for days to 50% flowering, plant height, number of tillers per plant, number of leaves per plant, leaf length, leaf width, leaf : stem ratio, number of nodes per plant, stem thickness, green fodder yield per plant, dry matter content, dry matter yield per plant, crude protein, crude protein yield per plant, HCN content and NDF content. The stability parameter in respect of these traits were calculated to evaluate relative stability of sixty eight different genotypes as per Eberhart and Russell (1966).

RESULTS AND DISCUSSION

The analysis of variance representing the mean sum of square due to different source of variation for sixteen characters are presented in Table 1. Pooled analysis of variance over three environments showed that the genotypic variance when tested against G x E were significant for all the characters except number of tillers per plant, crude protein content and HCN content. However, when tested against pooled deviations these variances revealed significant differences for all the traits except number of tillers per plant, Leaf: stem ratio and HCN content. Environmental variances were highly significant for all the traits. Further, indicated the significant of G x E interaction for all traits except number of leaves per plant and dry matter content. Presence of G x E interaction showed that pooled deviation effects were significant for all the traits except number of leaves per plant and crude protein yield per plant. Environment (linear) effects were significant for all the traits except number of tillers per plant. Further partitioned of variance E + (G x E) interaction was observed to be significant for all the traits except number of tillers per plant, dry matter content, HCN content and NDF content, whereas, G x E (linear) was significant for leaf length, leaf width, stem thickness, green fodder yield per plant, dry matter yield per plant, crude protein content and crude protein yield per plant when tested against pooled deviation.

The estimates of environmental index for sixteen characters are presented in Table 2. The environmental index was observed to be congenital in E_1 (15th June) for days to 50% flowering, number of tillers per plant, leaf width, crude protein content, crude protein yield per plant, HCN content and NDF content. The second environment E_2 (1st August) was not more fluctuating from over all mean, where as third Environment E_3 (15th September) was found rich for plant height, number of leaves per plant, leaf length, leaf : stem ratio, number of nodes per plant, stem thickness, green fodder yield per plant, dry matter content and dry matter yield per plant. Both E_1 and E_2 were suitable for leaf width, green fodder yield per plant and quality parameters. While E_1 and E_3 were found suitable for dry matter content, dry matter yield per plant.

Table 1: Analysis of variance (mean squares) for various traits over environments in sorghum

Characters	Mean sum of squares							
	Genotype	Environment	G x E	E (G x E)	Environment (L)	G x E (L)	Pooled deviation	Pooled error
d. f.	67	2	134	136	1	67	68	402
Days to 50% flowering	3.649**##	320.151**	1.794@@	6.180##	695.091##	1.156	1.652@@	17.050
Plant height	4.548**##	111.300**	6.549@@	3.118##	264.696##	1.363	5.507@@	71.410
Number of tillers per plant	0.849	2.981**	2.464@@	0.639	3.715	0.226	3.969@@	0.020
Number of leaves per plant	2.560**##	73.767**	0.879	1.905##	135.825##	0.817	0.955	1.320
Leaf length	2.312**##	330.851**	4.113@@	9.192##	1039.666##	2.127##	2.618@@	8.560
Leaf width	2.481**##	69.510**	4.848@@	2.869##	198.677##	1.844##	3.392@@	8.490
Leaf: stem ratio	1.580*	50.319**	2.321@@	1.555#	90.431##	0.789	2.580@@	0.008
Number of nodes per plant	3.103**##	99.955**	6.541@@	1.853##	150.872##	0.495	8.667@@	0.135
Stem thickness	3.078**##	71.478**	4.275@@	2.831##	197.590##	1.771##	3.086@@	0.003
Green fodder yield per plant	1.995**##	52.158**	4.492@@	4.970##	295.883##	4.658##	1.584@@	304.570
Dry matter content	4.757**##	35.114**	1.143	1.183	55.389##	0.561	1.449@@	2.450
Dry matter yield per plant	1.793**##	62.020**	4.055@@	5.733##	374.788##	5.028##	1.342@	28.760
Crude protein content	1.141#	36.523**	6.772@@	1.992##	95.506##	1.614#	5.180@@	0.189
Crude protein yield per plant	1.595**##	68.476**	4.695@@	11.493##	790.330##	10.524##	0.814	2.790
HCN content	1.299	10.922**	4.536@@	1.259	23.924##	1.183	4.142@@	130.810
NDF content	2.473**##	28.371**	1.646@@	1.289	52.128##	0.823	1.791@@	15.19

* and ** indicate significance of values at P=0.05 and 0.01, respectively when tested against G x E
@, @@ significant at P=0.05 and 0.01, respectively when tested against pooled error.
#, ## significant at P=0.05 and 0.01, respectively when tested against effective pooled deviation.

Table 2 : Estimation of environmental index (Ij) for each character under different environments

Characters	Environment			ΣI_j^2
	E_1	E_2	E_3	
Days to 50% flowering	-13.45	3.83	9.62	288.21
Plant height	-5.67	-22.96	28.63	1379.21
Number of tillers per plant	0.05	-0.03	-0.01	0.0044
Number of leaves per plant	-0.34	-0.96	1.30	2.71
Leaf length	-7.15	-7.95	15.11	342.63
Leaf width	4.19	-7.47	3.28	84.21
Leaf: stem ratio	-0.05	-0.09	0.14	0.03
Number of nodes per plant	-0.40	-0.89	1.29	2.60
Stem thickness	0.06	-0.13	0.07	0.03
Green fodder yield per plant	16.52	-37.33	20.70	2095.30
Dry matter content	0.62	-1.39	0.77	2.93
Dry matter yield per plant	5.32	-11.86	6.54	211.83
Crude protein content	0.81	-0.85	0.04	1.38
Crude protein yield per plant	2.28	-4.20	1.93	26.52
HCN content	-11.14	4.05	7.09	190.62
NDF content	-3.70	2.25	1.44	20.86

Crude protein content, crude protein yield per plant as compared to E_2 due to less fluctuating from overall mean. Among the parents, Indore 9A from female having a low mean value and significant bi (regression coefficient) with more than one value when tested against bi = 0 of bi =1 and non significant S^2di value indicated as stable under better environment (Table 3). Among male parents, HC 308 and PB 181 having high mean value than population mean, significant estimates of bi>1 of non-significant S^2di so considered as stable under better environment. Where as S 1049 and IS 2472 were having low mean value than population mean. Estimation bi <1 significant at bi =0, bi =1 and S^2di was non significant could be adopted under poor environment. Among hybrids, Indore 9A x ASFS 7, Indore 9A x GFS 4, Indore 9A x IS 21457, Indare 9A x DSIS 8315, Indore 9 A x PB 22, AKMS 14A x GFS 4, 3660A x GFS 4 and 3660A x Sholapuri having high mean value, significant estimates of bi>1 and S2di was non significant with least deviation could be considered for favorable environmental condition. Whereas, hybrid Indore 9 A x SSG 59-3, 3660 A x PB 78 and 3660 A x PB 181 having higher mean value with bi < 1 and non significant S^2di least deviation indicating stability for poor environment condition.

Out of three environments, E_2 (1^{st} August) was found suitable for sorghum cultivation. Hybrids Indore 9A x ASFS 7, Indore 9A x PB 78, AKMS-14A x Is 2472, 3660A x PB 45 showed high green fodder yield per plant, low HCN

Table 3 : Stability parameters of parents, hybrids and check for green fodder yield per plant

Genotype	Green fodder yield per plant		
	Mean	bi	S^{-2}di
Females			
Indore 9A	87.13	1.53*@	8.90
AKMS 14A	70.80	0.67	264.09
3660A	86.33	0.80*	-17.58
Males			
S 1049	41.89	0.51*@	-67.39
ASFS 7	46.20	0.70*	100.64
SSG 59-3	55.56	0.00	66.97
GFS 4	55.69	0.56	831.69
GFS 5	81.56	0.88*	-55.44
Sholapuri	168.22	-0.12	-78.01
HC 171	87.00	-0.05	451.65
HC 308	101.89	1.48*@	-85.19
IS 21475	59.89	0.42	44.63
PB 45	96.07	1.34*	389.67
IS 2472	62.87	0.63*@	-51.70
IS 3260	121.22	0.68	3102.7
DSIS 8315	89.67	0.64	197.03
PB 78	53.11	0.29	260.63
PB 181	126.78	1.58*@	-97.62
PB 22	62.22	1.08*	45.15
GFSH 1 (check)	124.78	-0.32	560.87
Crosses			
P_1 x P_4	109.44	1.40*	134.78
P_1 x P_5	128.22	3.00*@	-96.74
P_1 x P_6	85.24	0.73*@	-70.20
P_1 x P_7	151.56	3.61*@	-11.61
P_1 x P_8	93.42	0.56	171.69
P_1 x P_9	106.09	0.67	304.88
P_1 x P_{10}	99.09	0.82*	-57.09
P_1 x P_{11}	105.44	-0.10	-45.32
P_1 x P_{12}	80.60	1.49*@	-43.68
P_1 x P_{13}	100.78	0.27	1430.86
P_1 x P_{14}	105.44	0.77*	8.47
P_1 x P_{15}	65.33	-0.19	1375.17
P_1 x P_{16}	130.33	2.04*@	-97.98
P_1 x P_{17}	146.96	3.69*@	1097.95
P_1 x P_{18}	109.78	0.37	242.81
P_1 x P_{19}	188.33	3.81*@	-19.47
P_2 x P_4	107.78	0.87	3420.94
P_2 x P_5	96.67	1.14*	351.07
P_2 x P_6	94.96	0.98	1210.62
P_2 x P_7	82.31	1.24*@	-89.58
P_2 x P_8	76.22	0.39	183.61
P_2 x P_9	70.29	0.10	169.19
P_2 x P_{10}	114.00	0.40	465.73
P_2 x P_{11}	129.67	1.87*@	74.24

Contd. ....Table 3

Table 3 contd.....

P_2 x P_{12}	79.22	-0.21	-31.70
P_2 x P_{13}	124.11	2.32*@	208.24
P_2 x P_{14}	146.11	2.55*	1439.73
P_2 x P_{15}	89.44	0.51	1035.65
P_2 x P_{16}	149.89	2.38*@	650.25
P_2 x P_{17}	124.00	1.23	1088.30
P_2 x P_{18}	107.89	0.00	-92.12
P_2 x P_{19}	98.44	0.51	-101.53
P_3 x P_4	118.33	2.43*@	210.30
P_3 x P_5	122.44	2.38*@	68.15
P_3 x P_6	92.67	0.46	97.04
P_3 x P_7	109.33	1.41*@	-100.31
P_3 x P_8	110.24	1.58*	107.09
P_3 x P_9	129.22	1.23*@	-98.84
P_3 x P_{10}	153.78	3.54*@	23.77
P_3 x P_{11}	102.44	0.26	535.59
P_3 x P_{12}	87.24	0.27	163.59
P_3 x P_{13}	164.00	2.14*@	309.53
P_3 x P_{14}	76.11	0.25	-60.94
P_3 x P_{15}	84.11	-0.09	-87.13
P_3 x P_{16}	86.89	-0.25	-40.77
P_3 x P_{17}	101.00	-0.43*@	-78.59
P_3 x P_{18}	113.67	0.35*@	-45.41
P_3 x P_{19}	102.00	-0.32	4714.99
Mean	101.90	1.00	
S.E.±	15.53	0.48	

* Significant at 5 per cent level for (bi=0) and (S^{-2}di=0)
@ Significant at 5 per cent level for (bi= 1)
E_1: 15th, June 2005, E_2: 1st, August 2005, E_3: 15th, September 2005.

content and NDF content as compared to standard cheek (GFSH 1) in second environment E2 (1st August).

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