Variability for Yield and Quality Traits in (Single-Cut) Forage Sorghum [*Sorghum Bicolor* (L) Moench]

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An investigation was carried out using 62 diverse genotypes of forage sorghum to study the variability for yield and quality traits. Highly significant genotypic differences were found for all the traits studied. A wide range of variation was observed for days to 50% flowering, plant height, leaf length, leaf width, brix content, HCN content, green fodder yield/plant, dry matter yield/plant and dry matter (%), while moderate range was evident for tillers/metre row length, leaves/plant, leaf : stem ratio, and crude protein content. The genotypic coefficient of variation was high for green fodder yield/plant, dry matter yield/plant and HCN content which also manifested through high heritability and high genetic advance expressed as percentage of mean. Hence, phenotypic selection for these traits would be effective.

Key Words: Forage Sorghum, Genetic Advance, Heritability, Variability, White revolution

Introduction

Forage crops are important for the national economy since they form the nutritional base for our livestock population. In order to continue harnessing the fruits of White Revolution, emphasis on research relating to the improvement and management of forages is indeed very critical. With the increase in human population, the demand for animal products such as milk, meat and eggs in the human diet is increasing. The success of dairy and poultry programmes will largely depend on the availability of forages and feeds since almost 60-65% investment is accounted for these requirements.

A recent estimate indicates that there is a gap between total forage need and its availability by about 68% of green fodder and about 53% of dry forage. This deficit is likely to increase further because: (1) The area under forage crops is declining because of growing cereals and other cash crops to meet the increasing demand for food, (2) the animal population is also increasing every year by about 2%, (3) cultivable land is decreasing due to urbanization and industrial growth, and (4) forage crops in future are going to have competition from biofuel crops.

Sorghum [*Sorghum bicolor* (L.) Moench] locally known as Jowar, apart from grain, is widely used for forage production on account of its quick growth habit, quick recovery or regeneration after cutting or grazing and its ability to provide highly palatable and nutritious fodder for cattle. The crop has wide range of adaptability over diverse climates and soils. Sorghum green fodder is one of the cheapest sources of feed for milch, meat and draft animals.

Selection of superior plants is the basis for crop improvement. The estimates of variability, heritability and genetic advance for the yield components and their correlations with yield are considered to be of great importance for improving the crop. Genetic variability is the pre-requisite for selection because selection can be effective only when the population shows variability within itself. The study of heritability, genetic coefficient of variation and genetic advance is imperative as high values of these parameters show that the additive gene action is involved in governing the characters which can be exploited through selection.

Material and Methods

The experimental material for the present investigation was comprised of 62 diverse fodder genotypes and three checks (Table 1) obtained from the Main Sorghum Research Station, Navsari Agricultural University, Surat (Gujarat); Forage Research Station, Anand Agricultural University, Anand (Gujarat); as well as sorghum research stations located in Marathawada Agricultural University, Parbhani (Maharashtra); Mahatma Phule Krishi Vidhyapeeth, Rahuri (Maharashtra) and in Dr. Punjabrao Deshmukh Krishi Vidhyapeeth, Akola (Maharashtra). The experiment was conducted in a

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Table 1. List of genotypes evaluated with its source

S. No.	Genotypes	Source	Sr. No.	Genotypes	Source
1.	Amruta	FRS, A.A.U., Anand	32.	SG-348	FRS, A.A.U., Anand.
2.	AKFR-89	SRS, P.D.K.V., Akola	33.	SG-356	FRS, A.A.U., Anand
3.	AKFSV-3	MSRS, N.A.U., Surat	34.	SG-416	FRS, A.A.U., Anand
4.	C-10-2	FRS, A.A.U., Anand	35.	SG-426	FRS, A.A.U., Anand
5.	COFS-29	FRS, A.A.U., Anand	36.	SG-441	FRS, A.A.U., Anand
6.	IS-23960	SRS, P.D.K.V., Akola	37.	SG-479	FRS, A.A.U., Anand
7.	IS-22450	SRS, P.D.K.V., Akola	38.	SG-507	FRS, A.A.U., Anand
8.	IS-23980	SRS, P.D.K.V., Akola	39.	SG-544	FRS, A.A.U., Anand
9.	IS-SGL87	SRS, P.D.K.V., Akola	40.	SG-570	FRS, A.A.U., Anand
10.	M-35-1	FRS, A.A.U., Anand	41.	SRF-187	MSRS, N.A.U., Surat
11.	Mp-Chari	FRS, A.A.U., Anand	42.	SRF-204-1	MSRS, N.A.U., Surat
12.	PKV-801	SRS, M.A.U., Parbhani	43.	SRF-207	MSRS, N.A.U., Surat
13.	PKV-809	SRS, M.A.U., Parbhani	44.	SRF-283	MSRS, N.A.U., Surat
14.	Ruchira	SRS, M.P.K.V., Rahuri	45.	SRF-285	MSRS, N.A.U., Surat
15.	S-1049	FRS, A.A.U., Anand	46.	SRF-286	MSRS, N.A.U., Surat
16.	SG-16	FRS, A.A.U., Anand	47.	SRF-288	MSRS, N.A.U., Surat
17.	SG-25	FRS, A.A.U., Anand	48.	SRF-289	MSRS, N.A.U., Surat
18.	SG-65	FRS, A.A.U., Anand	49.	SRF-311	MSRS, N.A.U., Surat
19.	SG-85	FRS, A.A.U., Anand	50.	SRF-312	MSRS, N.A.U., Surat
20.	SG-105	FRS, A.A.U., Anand	51.	SRF-314	MSRS, N.A.U., Surat
21.	SG-138	FRS, A.A.U., Anand	52.	SRF-315	MSRS, N.A.U., Surat
22.	SG-149	FRS, A.A.U., Anand	53.	SRF-319	MSRS, N.A.U., Surat
23.	SG-150	FRS, A.A.U., Anand	54.	SRF-322	MSRS, N.A.U., Surat
24.	SG-173	FRS, A.A.U., Anand	55.	SRF-324	MSRS, N.A.U., Surat
25.	SG-214	FRS, A.A.U., Anand	56.	SRF-1663	MSRS, N.A.U., Surat
26.	SG-230	FRS, A.A.U., Anand	57.	SSG-59-3	FRS, A.A.U., Anand
27.	SG-251	FRS, A.A.U., Anand	58.	SSG-59-3 (Brown glume)	SRS, P.D.K.V., Akola.
28.	SG-269	FRS, A.A.U., Anand	59.	SSV-84	SRS, M.A.U., Parbhani.
29.	SG-289	FRS, A.A.U., Anand	60.	GFS-3 (Check 1)	FRS, A.A.U., Anand
30.	SG-314	FRS, A.A.U., Anand	61.	GFS-4 (Check 2)	MSRS, N.A.U., Surat
31.	SG-316	FRS, A.A.U., Anand	62.	GFS-5 (Check 3)	FRS, A.A.U., Anand

FRS, A.A.U., Anand – Forage Research Station, Anand Agricultural University, Anand
SRS, P.D.K.V., Akola – Sorghum Research Station, Punjabrao Deshmukh Krushi Vidhyapeeth, Akola
MSRS; NAU, Surat – Main Sorghum Research Station, Navsari Agricultural University, Navsari
SRS, M.A.U., Parbhani – Sorghum Research Station, Marathawada Agril. University, Parbhani
SRS, M.P.K.V., Rahuri – Mahatma Phule Krushi Vidhyapeeth, Rahuri

Randomized Complete Block Design (RCBD) with three replications. Each genotype consisted of three rows each of two metre length spaced 30 cm apart from each other with a plant to plant distance of 10 cm. The experimental material was dibbled on 10th July 2008 at the College farm, NM College of Agriculture, Navsari Agricultural University, Navsari. The plant protection measures, irrigation, fertilizer schedule and other cultivation aspects were adopted as per recommended package of practices specific to the crop for South Gujarat Heavy Rainfall Zone (AES-III). From each plot in all the three replications, five randomly selected plants were tagged for recording the observations on days to 50% flowering, tillers per metre row length, plant height (cm), leaves per plant, leaf length (cm), leaf width (cm), leaf:stem ratio, brix content (%), hydrocyanic acid content (ppm), crude protein content (%), green fodder yield/plant (g), dry matter yield/plant (g)and dry matter (%). The mean values of data from the tagged plants were computed and used for statistical analysis. The phenotypic and genotypic coefficients of variation (PCV and GCV, respectively) were calculated as per Burton (1952). Heritability (h2) and expected genetic advance (GA) were calculated by the formula suggested by Allard (1960) while, Expected Genetic Advance in terms of per cent of mean (GA%) was calculated by the methodology proposed by Johnson *et al.* (1955).

Results and Discussion

Analysis of variance (Table 2) revealed highly significant differences among the genotypes for all the traits evaluated which indicated that there was considerable amount of genetic variability in the experimental material indicating the suitability of material under study.

Mean performance of each genotype for all the 13 traits evaluated in given in Table 3. Result revealed that wide range of phenotypic variation (Table 4) was observed for days to 50% flowering, plant

Table 2. Analysis of variance showing means square for 13 traits in forage sorghum

Source	D.F.	Days to 50% flowering	Tillers/ metre row length	Plant height (cm)	Leaves/ plant	Leaf length (cm)	Leaf width (cm)	Leaf: Stem ratio	Brix content (%)	HCN content (ppm)	Crude protein content (%)	Green fodder yield/plant (g)	Dry matter yield / plant (g)	Dry Matter (%)
Replications	2	1.04	0.49	1.39	0.08	4.46	0.04	0.001	0.01	24.70	0.05	7.46	30.38	10.23
Genotypes	61	297.01**	17.52**	2721.99**	8.42**	212.32**	3.94**	0.021**	7.06**	12744.09**	6.05**	18131.81**	2313.70**	186.92**
Error	122	1.56	0.68	352.73	0.20	7.70	0.07	0.002	0.08	21.00	0.06	326.21	26.89	32.57

** Significant at 0.01 p level

height, leaf length, leaf width, brix content, HCN content, green fodder yield/plant, dry matter yield/ plant and % dry matter. This indicated that there is enormous scope for selection of desirable genotypes for higher fodder yield from the material evaluated. These results corroborated with the earlier findings reported in fodder sorghum by Agarwal (2004) and Choudhary *et al*. (2005) where in for days to 50% flowering, plant height, leaf length, leaf width, green fodder yield/plant and dry matter yield/plant. The traits tillers/metre row length, leaves/plant, leaf:stem ratio, crude protein content had moderate range of phenotypic variation. Agarwal (2004) and Choudhary *et al.* (2005) reported moderate range of variation for leaves/plant and crude protein content.

High magnitude of genotypic and phenotypic variances were recorded for days to 50% flowering, plant height, leaf length, HCN content, green fodder yield/plant, dry matter yield/plant and % dry matter. While for tillers/metre row length, leaves/plant, leaf width, leaf:stem ratio, brix content and crude protein content, the estimates of both the genotypic as well as phenotypic variances were low which suggested that the phenotypic variance in these traits was not the true reflection of their respective genotypic variance. Simultaneously, it was also found that all these characters had greater genotypic variance than phenotypic variance except for leaf:stem ratio, indicating that that these traits were least influenced by environment. Similar results were also reported for days to 50% flowering, plant height, leaf length and leaves/plant by Kaushik *et al.* (1996).

The estimates of GCV (%) and PCV (%) were comparatively high for green fodder yield/plant, dry matter yield/plant and HCN content, which indicated the presence of high amount of both the genotypic as well as phenotypic variability for these traits in the genetic material. Earlier, high estimates of GCV (%) as well as PCV (%) were reported by Anup and Vijaykumar (2000), Agarwal (2004) and Kishore and Singh (2005) for green fodder yield/plant and dry matter yield/plant. The values of genotypic and phenotypic coefficients of variation were moderate for tillers/metre row length, leaves/plant, leaf width, leaf:stem ratio, crude protein content and % dry matter. Similar results were earlier reported in fodder sorghum for L:S ratio and crude protein content by Anup and Vijaykumar (2000); for tillers/metre row length, leaves/plant and crude protein content by Kishore and Singh (2005). The estimates of GCV (%) and PCV (%) were in low magnitude for days to 50% flowering, plant height, leaf length and brix content. Similar findings were also obtained in fodder sorghum for days to flowering and plant height by Anup and Vijaykumar (2000); for leaf length by and Kishore and Singh (2005).

A comparison of estimates of GCV (%) with their corresponding PCV (%) for different traits revealed that in general, the estimates of GCV (%) were close to the estimates of PCV (%) for all the characters evaluated except for leaves/plant. This indicated that except for leaves/plant, majority of the traits studied were least influenced by the environment. This result was in accordance with the findings of Agarwal (2004) for days to 50% flowering, leaf length, green fodder yield/plant, dry fodder yield/plant and crude protein.

The estimates of heritability in broad sense for different traits revealed that, the high values of heritability were observed for days to 50% flowering, tillers/metre row length, leaves/plant, leaf length, leaf width, leaf:stem ratio, brix content, HCN content, crude protein content, green fodder yield/plant and dry matter yield/plant. The higher estimates of heritability for these traits indicated that simple selection on the basis of phenotypic performance of genotypes would

Table 3. Mean performance of 62 genotypes of forage sorghum

S. No.	Genotypes	Traits												
		Days to 50% flowering	Tillers/ metre row length	Plant height (cm)	Leaves/ plant	Leaf length (cm)	Leaf width (cm)	Leaf: Stem ratio	Brix content (%)	HCN content (ppm)	Crude protein content (%)	Green fodder yield/ plant (g)	Dry matter yield/ plant (g)	Dry Matter (%)
1	Amruta	87.67	9.00	258.73	11.07	84.87	9.32	0.31	11.10	71.80	7.87	431.33	156.00	36.17
2	AKFR-89	76.67	10.00	144.30	8.47	66.93	4.09	0.21	11.97	110.13	5.71	151.33	38.00	25.06
3	AKFSV-3	76.67	10.67	208.13	7.33	64.60	4.63	0.43	11.03	38.42	5.67	170.67	32.00	18.81
4	C-10-2	58.00	11.33	187.33	7.07	63.80	4.85	0.34	11.33	220.07	6.38	165.33	32.00	19.37
5	COFS-29	59.67	11.67	193.20	5.93	57.20	3.23	0.30	11.67	76.48	3.39	71.00	19.33	27.22
6	IS-23960	76.00	11.00	241.33	9.13	80.87	5.38	0.27	12.33	112.80	6.24	189.33	39.50	20.85
7	IS-22450	79.00	7.67	173.00	10.47	70.27	5.05	0.34	11.60	124.75	4.01	123.33	42.60	34.50
8	IS-23980	83.33	9.33	264.40	11.33	69.93	5.24	0.37	10.70	74.23	7.33	202.00	73.00	36.11
9	IS-SGL87	75.00	12.67	185.93	7.87	64.60	3.63	0.52	11.40	90.47	4.20	156.00	33.00	21.24
10	M-35-1	88.33	10.00	210.00	11.73	76.13	5.26	0.36	11.00	35.20	6.80	246.00	68.00	27.66
11	MP-Chari	49.67	12.33	183.07	6.20	58.27	3.85	0.33	12.63	211.89	5.47	87.67	16.50	18.80
12	PKV-801	81.00	6.67	167.73	11.00	75.67	7.97	0.40	13.50	195.82	7.95	335.33	118.50	35.46
13	PKV-809	86.33	7.67	212.40	10.73	70.40	5.93	0.34	12.50	113.28	7.61	294.00	109.67	37.29
14	Ruchira	87.33	12.00	211.67	10.53	71.73	4.98	0.30	10.50	130.48	7.78	332.33	90.50	27.20
15	S-1049	50.33	12.33	185.67	7.20	62.27	4.69	0.43	13.00	246.10	7.41	79.33	24.17	30.55
16	SG-16	65.33	9.33	170.87	7.87	73.80	4.86	0.38	5.50	27.49	4.23	121.33	35.00	28.82
17	SG-25	65.67	9.33	184.33	8.13	64.73	4.06	0.40	12.20	32.48	4.35	134.00	39.33	29.36
18	SG-65	87.33	8.33	245.33	11.40	73.07	5.34	0.39	13.53	14.38	5.30	149.33	63.33	42.45
19	SG-85	86.33	5.33	199.07	11.53	84.13	7.08	0.41	11.00	126.33	6.68	226.00	96.00	42.47
20	SG-105	86.33	6.00	255.53	10.80	72.60	4.58	0.33	11.20	118.05	5.31	159.33	62.67	39.35
21	SG-138	73.00	6.33	177.07	9.27	57.27	4.39	0.41	12.30	142.06	6.17	172.00	54.00	31.36
22	SG-149	73.33	6.33	193.67	7.87	72.07	4.57	0.46	12.97	92.50	4.00	130.67	33.83	26.04
23	SG-150	76.00	7.00	228.73	11.47	68.87	4.30	0.23	13.00	140.79	6.08	172.00	55.33	32.24
24	SG-173	87.33	7.67	248.33	11.80	67.80	4.86	0.28	10.40	144.91	4.60	136.00	54.50	40.19
25	SG-214	85.00	4.33	200.93	10.53	65.33	6.45	0.42	11.00	175.87	6.04	209.33	65.00	31.03
26	SG-230	65.00	11.67	196.93	7.93	63.80	5.23	0.32	10.70	165.54	4.41	126.67	27.00	21.14
27	SG-251	72.67	8.00	201.50	8.20	66.20	4.75	0.24	13.77	172.71	5.96	154.67	56.20	36.29
28	SG-269	65.33	10.00	168.93	8.13	60.47	3.62	0.45	12.07	43.48	3.99	103.33	24.00	23.14
29	SG-289	76.67	7.67	217.27	9.80	70.20	5.00	0.27	12.47	236.84	6.47	209.33	79.67	37.99
30	SG-314	76.67	9.33	209.47	10.20	71.80	4.79	0.27	13.57	185.15	5.53	144.33	59.17	41.34
31	SG-316	63.67	8.33	176.80	7.40	54.67	3.25	0.41	12.27	225.65	3.63	90.00	21.17	23.57
32	SG-348	77.33	7.00	195.20	8.40	64.73	4.29	0.25	11.00	70.31	7.13	201.33	74.00	36.76
33	SG-356	67.33	12.00	190.00	7.00	52.60	4.60	0.29	12.03	180.37	4.06	90.00	32.33	35.97
34	SG-416	76.00	6.00	234.73	11.47	71.60	5.93	0.33	10.70	147.93	7.22	249.33	46.00	18.42
35	SG-426	76.00	11.00	231.13	9.60	66.20	5.34	0.35	11.47	96.06	6.73	221.67	46.83	21.18
36	SG-441	66.00	12.00	148.30	8.07	51.80	3.47	0.28	10.20	69.93	4.03	93.33	19.50	22.38
37	SG-479	76.00	7.33	210.80	9.80	63.60	7.76	0.19	11.00	214.16	7.71	316.67	77.17	24.84
38	SG-507	82.67	8.00	252.60	10.87	81.47	5.42	0.28	11.23	122.98	6.76	234.67	85.33	36.74
39	SG-544	67.00	8.33	216.80	7.60	74.40	5.77	0.34	12.67	75.36	6.75	212.67	54.17	25.57
40	SG-570	86.33	6.00	243.73	9.27	68.87	5.23	0.36	8.77	214.65	6.66	235.33	59.33	25.70
41	SRF-187	87.67	5.67	258.50	10.40	79.40	6.13	0.33	12.53	184.06	6.66	190.67	102.00	56.68
42	SRF-204-1	76.67	8.00	191.13	9.60	75.47	6.15	0.28	11.33	180.23	6.74	212.33	61.00	28.76
43	SRF-207	84.67	6.00	230.73	10.40	78.73	6.40	0.37	12.83	166.65	8.04	377.00	106.33	28.25
44	SRF-283	84.33	12.67	227.07	9.20	73.60	4.79	0.44	11.00	175.70	5.65	183.33	39.33	21.49
45	SRF-285	81.00	7.67	181.47	8.80	78.80	4.65	0.40	12.83	288.48	4.65	126.67	65.33	51.62
46	SRF-286	80.67	4.67	208.53	9.40	76.87	5.09	0.27	11.20	135.47	6.06	178.67	60.33	33.82
47	SRF-288	81.00	9.67	222.47	8.47	76.60	5.22	0.39	11.80	230.70	6.86	235.67	65.00	27.63
48	SRF-289	80.33	7.33	163.20	8.20	66.75	4.40	0.45	11.23	129.76	5.28	124.00	41.33	33.34
49	SRF-311	74.33	14.33	211.67	9.40	71.60	4.68	0.32	11.80	141.16	6.37	184.67	48.33	26.24
50	SRF-312	79.00	6.67	182.00	7.87	59.87	4.46	0.52	12.23	228.97	4.16	114.67	36.83	34.25
51	SRF-314	77.00	8.67	244.77	12.20	80.40	6.53	0.41	14.23	124.73	7.59	275.33	74.00	27.01
52	SRF-315	71.00	8.67	226.13	9.27	73.67	4.39	0.48	9.83	46.50	5.24	180.00	43.73	24.29
53	SRF-319	87.67	4.33	189.47	9.53	77.20	4.83	0.64	13.80	148.53	7.58	204.67	63.67	31.86
54	SRF-322	80.00	10.00	186.67	7.27	78.20	4.73	0.37	14.70	192.75	4.20	134.33	45.50	37.10
55	SRF-324	67.00	10.33	195.13	8.27	64.80	4.73	0.21	12.83	76.67	8.08	230.67	45.27	19.69
56	SRF-1663	77.00	5.67	180.40	7.67	70.07	4.43	0.26	10.53	85.83	6.45	183.33	58.27	31.77
57	SSG-59-3	66.00	11.00	195.00	6.20	59.27	2.94	0.26	12.00	73.68	3.85	68.67	17.77	27.91
58	SSG-59-3 (Brow glum)	66.00	11.00	162.91	7.13	63.00	3.48	0.30	11.13	163.32	3.83	82.67	24.17	33.54
59	SSV-84	89.00	7.33	201.73	9.47	74.80	4.81	0.34	13.77	265.21	6.39	170.00	62.00	37.18
60	GFS-3	86.67	8.67	226.40	11.20	81.93	4.48	0.38	16.23	220.33	9.55	184.33	65.00	35.71
61	GFS-4	50.67	12.67	139.73	6.07	46.27	3.61	0.42	12.23	170.19	5.23	38.67	11.33	30.44
62	GFS-5	64.67	6.33	160.20	6.47	58.73	4.33	0.38	14.23	152.80	7.28	66.67	25.83	38.72
		0.72	0.47	10.84	0.26	1.60	0.15	0.024	0.17	2.65	0.14	10.43	2.99	3.30
	CD at 5%	2.02	1.33	30.36	0.72	4.49	0.42	0.068	0.47	7.41	0.40	29.19	8.38	9.22
	CV %	1.65	9.36	9.23	4.89	4.02	5.22	11.985	11.90	139.83	5.96	178.63	54.45	30.77

Table 4. Phenotypic range, General mean, Variance components, Phenotypic coefficient of variation (PCV), Genotypic coefficient of variation (GCV), Heritability (H^2 b) and Genetic advance (% of mean) for the traits studied at Navsari, Gujarat during 2008 rainy season

Characters	Phenotypic range	G.M.	σ^2 (P)	σ^2 (G)	σ^2 (E)	PCV (%)	GCV (%)	Heritability (%)	GA (% of mean)
Days to 50% flowering	49.67 – 89.00	75.61	98.48	100.05	1.16	13.23	13.13	98.44	26.83
Tillers/metre row length	4.33 – 14.33	8.78	5.61	6.29	0.68	28.57	26.99	89.27	52.53
Plant height (cm)	139.73 – 264.40	203.39	7898.75	1142.48	352.74	16.62	13.82	69.13	23.67
Leaves/plant	5.93 – 12.20	9.08	2.74	2.94	0.20	18.88	18.23	93.28	36.28
Leaf length (cm)	46.27 – 84.87	69.12	68.21	75.91	7.70	12.61	11.95	89.85	23.33
Leaf width (cm)	2.94 – 9.32	4.97	1.29	1.36	0.07	23.45	22.86	95.04	45.71
Leaf:Stem ratio	0.19 – 0.64	0.35	0.01	0.01	0.002	25.79	22.86	78.40	41.65
Brix content (%)	5.50 – 16.23	11.90	2.33	2.41	0.08	13.05	12.82	96.50	25.94
HCN content (ppm)	14.38 – 288.48	139.83	4241.03	4262.03	21.00	46.68	46.57	99.51	95.70
Crude protein content (%)	3.39 – 9.55	5.96	2.00	2.06	0.06	24.07	23.72	97.06	48.13
Green fodder yield/plant (g)	38.67 – 431.33	178.63	5935.20	6261.41	326.21	44.30	43.13	94.79	86.50
Dry matter yield/plant (g)	11.33 – 156.00	54.45	762.27	789.16	26.89	51.59	50.70	96.59	102.66
Dry Matter (%)	18.42 – 56.68	30.77	51.54	84.02	32.57	29.79	23.31	61.23	37.57

also be more efficient in further improvement of these traits. Similar findings for high heritability estimates were also obtained for green fodder yield/plant and dry fodder yield/plant in fodder sorghum by Anup and Vijaykumar (2000); for days to 50% flowering and crude protein content by Kishore and Singh (2005). Moderate values of heritability were registered by plant height and % dry matter. This suggested that it was moderately influenced by environment and genetic enhancement through selection might be difficult due to masking effects of the environment on the genotypic effect. Moderate estimates of heritability revealed in the present investigation for plant height was earlier reported by Patil *et al.* (1996) and Kishore and Singh (2005) also.

Genetic advance expressed as percentage of mean [GA (% mean)] revealed that high estimates of genetic advance (% mean) were observed for green fodder yield/plant, dry matter yield/plant and HCN content. This indicated that inheritance of these characters were under the control of additive genes and selection would be rewarding for further improvement of these traits. High estimates of genetic advance (% mean) were reported for green fodder yield/plant and dry fodder yield/plant by Anup and Vijaykumar (2000) and Kishore and Singh (2005). The moderate estimates of genetic advance (% mean) were observed for tillers/metre row length, leaf width, leaf:stem ratio and crude protein content indicating that these characters were under the influence of both additive as well as non-additive gene effects thereby suggesting that reciprocal recurrent selection would be effective for further improving these traits. Moderate estimates of genetic advance were also manifested for L:S ratio and crude protein by Anup and Vijaykumar (2000); for leaf width and crude protein by Sankarpandian (2002); for tillers/metre row length and crude protein by Kishore and Singh (2005). Genetic advance (% mean) were low in magnitude for characters like days to 50% flowering, plant height, leaves/plant, leaf length, brix content and % dry matter suggesting that these traits were under the influence of non-additive genes, thus emphasizing the importance of heterosis breeding for exploitation of these non-additive genes. Earlier, Sankarpandian (2002) and Anup and Vijaykumar (2000) reported the similar results to this findings for days to 50% flowering and for leaves/plant, respectively.

High heritability coupled with high genetic advance (% mean) were observed for green fodder yield/plant, dry matter yield/plant and HCN content revealing that these characters can be improved by simple phenotypic selection as they are more likely to be controlled by additive gene action. Similar evidences were observed for green fodder yield/plant as well as dry fodder yield/plant by Anup and Vijaykumar (2000). In the present investigation the estimates of high heritability and moderate genetic advance (% mean) were observed for tillers/metre row length, leaf width, leaf:stem ratio and crude protein content emphasizing the role of both additive and non-additive gene action for these traits. Hence, recurrent selection or reciprocal recurrent selections are the best suited method for exploitation of both additive and non-additive genetic components. Similar findings were reported by Anup and Vijaykumar (2000) for L:S ratio and crude protein by Sankarpandian (2002), while Kishore and Singh (2005) for leaf width and crude protein per cent. Further, high heritability coupled with low genetic advance (% mean) was exhibited by days to 50% flowering, leaves/plant, leaf length and brix content. This indicated that there is little scope for further improvement through selection for these traits due to the involvement of non-additive gene effect in the inheritance of these traits. These findings were in conformity with the earlier results of Anup and Vijaykumar (2000) for days to 50% flowering and leaves/plant. Plant height and % dry matter exhibited moderate heritability along with low genetic advance (% mean) indicating that these traits were under the influence of non-additive gene action. Earlier, Patil *et al.* (1996) and Kishore and Singh (2005) reported similar findings for plant height.

In the present investigation, considering the importance of genetic parameters like GCV, heritability and genetic advance (% mean) together, it is evident that green fodder yield/plant, dry matter yield/plant and HCN content are the most important traits in fodder in fodder sorghum improvement. Selection for these traits in the segregating generations would be fruitful for further genetic improvement in fodder sorghum.

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*Original not seen.