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GENETIC VARIABILITY IN LAND RACES OF FORAGE SORGHUM {*Sorghum bicolor* (L) MOENCH} COLLECTED FROM DIFFERENT GEOGRAPHICAL ORIGIN OF INDIA

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Abstract- An evaluation of 102 land races of forage sorghum for days to 50 % flowering, plant height, number of leaves per plant, leaf length, leaf breadth and fodder yield per plant in augmented block design during 2009-10 and 2010-11 revealed highly significant differences among the accessions. High heritability accompanied with high GA as per cent of mean was observed for days to 50% flowering, plant height, number of leaves per plant, leaf length and fodder yield per plant suggested that these characters are under additive gene action and gives better scope for selection. Fodder yield was positively and significantly correlated with number of leaves per plant, leaf length, leaf width and panicle length. The characters leaf width, number of leaves per plant, days to 50% flowering and panicle length showed positive direct effect on fodder yield. Where as leaf length showed positive significant association with fodder yield but the direct effect of leaf length was negative with fodder yield, which may be a result of the indirect effect of this trait via other traits. Based on the results of the means of the two years considering together for the various traits, the accession E-143 and EJN-11 was found to be superior for earliness, EA-2 and GUB-50 for plant height, E-159 for leaf characters and E-203 and GGUB-39 for fodder yield. Therefore these accessions should be utilized in further breeding program for developing superior varieties..
Key words - correlation, genetic advance, heritability, path coefficient, Variability

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Introduction:

Sorghum {*Sorghum bicolor* (L) Moench} is one of the most important drought tolerant crops which allow farmers to use one third less water than similar crops such as corn. In India, sorghum is cultivated in 7.53 mha, of which 2.89 mha is cultivated during rainy and kharif season with a production of 3.05 mt (Anonymous 2010). The major sorghum growing states are Andhra Pradesh, Gujarat, Karnataka, Madhya Pradesh, Maharashtra, Rajasthan and Tamil Nadu. In Gujarat the area under sorghum cultivation is 1.17 lakh ha with a production of 1.28 lakh tones and productivity being 1151 kg/ha (Anonymous, 2011). Sorghum area is fast decling for the past 10 decades yet it will continue to be an important food grain in India since its relative importance for alternate uses such as poultry and cattle feed, livestock forage, starch, sugar, alcohol and other uses will increase. It is therefore of paramount importance that technological developments are extended to increase the productivity and sustainability of sorghum production. Landraces or farmer varieties constitute the basic material for developing any variety or hybrid. An autochthonous landrace is a variety with a high capacity to tolerate biotic and abiotic stress, resulting in high yield stability and an intermediate yield level under a low input agricultural system". It is well established fact that the progress in improvement of a crop depends on the degree of variability in the desired character in the base material vis-a-vis germplasm collection. The study of relationships among quantitative traits is important for assessing the feasibility of joint selection of two or more traits and hence for evaluating the effect of selection for secondary traits on genetic gain for the primary trait under consideration. A positive genetic correlation between two desirable traits makes the job of the plant breeder easy for improving both traits simultaneously. Path coefficient analysis was performed to qualify the direct and indirect contributors of yield components and developmental traits of fodder yield. Therefore the present investigation was undertaken to study the variability in land races of sorghum during kharif 2009-10 to 2010-11.

Materials and Methods

One hundred two forage sorghum landraces collected from different geographical origin of India were used for the present study. The trial was grown in augmented block design during the two seasons namely *Kharif* 2009-10 and *Kharif* 2010-11 at Sorghum Research Station, Sardarkrushinagar Dantiwada Agricultural University, Deesa (Gujarat). Deesa is situated at latitude of 24.5˚ N and longitude 72˚ E and at an elevation of 136 M above the Mean Sea Level. The soil of the field was sandy in texture with pH value of 7.5 to 8.00 having good physical and chemical properties (Organic Carbon= 0.23, EC dsm^{-} = 0.232, K_2O= 259.9 kg/ha and P_2O_5= 46.2 kg/ha). The experimental unit was a single-row plot of 6.75 m long, spaced at 0.45 m apart. NPK 120:40:00 fertilizers was applied as half basal dose of nitrogen and full dose of phosphorus at the time of sowing and half nitrogen applied after one month of sowing. Plots were thinned down after two weeks of crop emergence and plant-to-plant distance of 0.10 m was maintained. The experimental years showed different temperature regimes, humidity, rain fall and sunshine hours during the crop durations. The all other recommended agronomical practices were followed to raise a good crop in both the seasons. Data were taken on days to 50 % flowering, plant height (cm), number of leaves per plant, leaf length (cm), leaf breadth (cm) and fodder yield per plant (g). Statistical analysis was done according to the standard statistical procedures (Federer, 1996; Burton, 1952; Johnson et al., 1955; Al -Jibouri et al., 1958 and Dewey and Lu, 1959).

Result and Discussion

Genotypic coefficient of variation (GCV) was maximum for fodder yield per plant (36.78 %) followed by panicle length (32.77 %) and its difference with phenotypic coefficient of variation (PCV) was found less. Differences between GCV and PCV for other traits were also found to be less indicating that these traits were less affected by environmental fluctuations (Table 1). The high values of GCV and PCV for all the traits suggested that there is a possibility of improvement through direct selection for the traits. High heritability coupled with high genetic advance was observed for plant height, days to 50% flowering and leaf length indicating that these characters are controlled by additive gene action and phenotypic selection for these characters will be effective. The expected genetic advance might have been biased upward as it is based on the estimates of heritability in broad sense, secondly in the augmented design the estimation of mean square due to the error is based on the check variety only, and hence, it might have given the high estimates of genetic variances in it. High heritability and high genetic advance for these traits was also observed by earliers (Deepalakshmi and Ganesamurthy, 2007, Warked et al., 2008 and Mahajan et al., 2011).

The genotypic and phenotypic correlation coefficients worked out among different characters including fodder yield per plant revealed that in general the phenotypic correlation coefficient were similar to genotypic correlation coefficient (Table 2). In some cases the phenotypic correlation was slightly higher then the genotypic correlation coefficients, which may be a result of modifying effect of environments on the association of the characters. The fodder yield per plant showed positive and significant correlation with leaf width, number of leaves per plant, days to 50% flowering and panicle length. It is also noticed that characters that exhibited positive associations with fodder yield have also showed positive associations among them selves. Out of these traits some traits like plant height, days to 50% flowering and leaf length are having the high broad sense heritability with high expected genetic advance should be used in selection programme. Similar views have been reported by earlier workers (Sankarapandian, 2010 Jain et al., 2011).

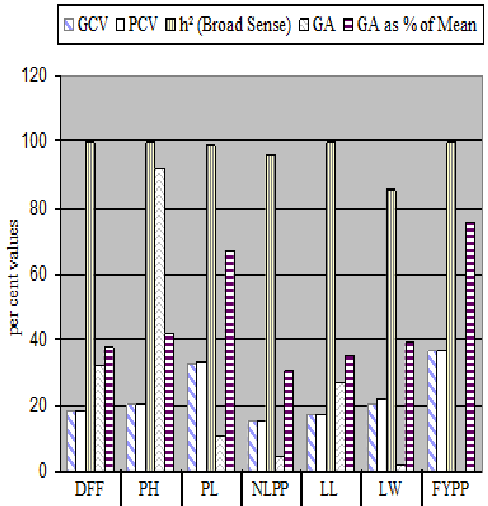
Correlation co-efficient indicates only the general associations between any two traits without tracing any possible causes of such associations. In such situations, the path coefficient analysis at phenotypic level (Table 3 and fig. 1) is done to partition the correlation coefficients in to direct and indirect effects. Fodder yield per plant was taken as dependent variable while computing the path coefficient. The path coefficient analysis based on both the seasons revealed that the characters like leaf width, number of leaves per plant, days to 50% flowering and panicle length which had positive significant association with green fodder yield also exerted positive and high direct effects on fodder yield. Where as leaf length showed positive significant association with fodder yield but the direct effect of leaf length was negative with fodder yield, which may be a result of the indirect effect of this trait via other traits. Thus the present study revealed that these traits in determining the fodder yield and therefore, their values in constructing the selection criterion. Positive direct effect of number of leaves per plant and leaf width on fodder yield was also reported by earlier reporters (Jain et al, 2010, Prakash et al., 2010 and Jain et al., 2011).Thus the present study revealed that the plant height, leaf length and width, number of leaves per plant, days to 50% flowering and panicle length are the important traits for deciding the fodder yield but the high residual effect (0.8502) revealed that the other traits like stem girth, number of tillers per plant and leaf stem ratio also important traits. So that the consideration should be given to these traits while planning a breeding strategy for increase the fodder yield.

Based on the results of the means of the two seasons the accessions exhibited good variability in all the quantitative traits: the days to 50% flowering (38.00-105.5 days), plant height (121.00-302.25 cm), number of leaves per plant (6.00-20.50), Panicle length (4.00-36.50 cm), leaf length (37.50-103.50cm), leaf width (2.75-9.25 cm), fodder yield (0.116-0.512 kg /plant), showed wider range. Some of the accessions identified superior for the different morphological characters are EJN-11 (38.0), E-143 (42.5), ERN-13 (44.5), EG-35 (46.0) and E-186 (46.0) were for earliness, EA-2 (302.25), GUB-50 (300.75), EJN-26 (297.0), ERN-29 (292.5) and GGUB-56 (291.75) for plant height, E-186 (36.5), GGUB-47 (33.0), E-153 (31.0), ERS-25 (28.5) and EB-2 (23.0) for panicle length, ERN-11 (20.5), E-159 (20.0), GGUB-32 (20.0), GGUB-47 (19.0) and GGUB-30 (19.0) for number of leaves per plant, EB-2 (103.5), E-159 (99.0), GGUB-57 (99.0), E-195 (98.0) and EG-40 (94.0) for leaf length, GGUB-47 (9.3), E-159 (9.0), GGUB-52 (8.5), E-186 (8.3) and E-197 (7.8) for leaf width and E-203 (0.5125), GGUB-39 (0.512), EG-40 (0.438), E-1 (0.4165) and GGUB-19

(0.4125) for fodder yield (Table 4).

The conclusion that can be reached from the present study is that the leaf length and width, number of leaves per plant, days to 50% flowering and panicle length are the important component traits for fodder yield per plant. The accession viz., E-143 and EJN-11 was found to be superior for earliness, EA-2 and GUB-50 for plant height, E-159 for leaf characters and E-203 and GGUB-39 for fodder yield. Therefore these accessions should be utilized in further breeding program for developing superior varieties.

Table 1- Variability parameters in landraces of forage sorghum (Pooled over two year)



	DFF	PH	PL	NLPP	LL	LW	FYPP
GCV	18.34	20.2	32.77	15.12	17.11	20.42	36.78
PCV	18.37	20.22	33.03	15.45	17.13	22.08	36.84
h² (Broad Sense)	99.7	99.8	98.4	95.7	99.8	85.5	99.7
GA	32.01	91.56	10.89	4.56	27.08	2.22	0.18
GA as % of Mean	37.74	41.58	66.97	30.47	35.21	38.91	75.65

Characterstics (DFF= Days to 50% flowering; PH= plant height; PL panicle length; NLPP= number of leaves per plant; LL=leaf length; LW= leaf width; FYPP= fodder yield per plant

Table 2- Phenotypic correlation coefficient on the basis of unadjusted values between different characters in sorghum over two year

Characters	50% Flowering	Plant Height	Panicle length	Number of leaves / Plant	Leaf length	Leaf width	Fodder yield/ Plant
50% Flowering	1.00	-0.062	0.081	-0.096	0.499**	-0.029	0.106
Plant Height		1.00	-0.064	0.057	-0.005	0.13	0.041
Panicle Length			1.00	0.14	0.282**	0.215*	0.157
No. of leaves/ plant				1.00	0.206*	0.293**	0.367**
Leaf Length					1.00	0.479**	0.282**
Leaf width						1.00	0.427**
Fodder yield/Plant							1.00

Table 3. Direct (diagonal) and indirect (non diagonal) effects of different characters on green fodder yield in sorghum at genotypic level over two year

Characteristics	50% Flow-ering	Plant Height	Panicle length	Number of leaves / Plant	Leaf length	Leaf width
50% Flowering	0.1584	-0.0097	0.0129	-0.0152	0.0791	-0.0047
Plant Height	0.0058	-0.0942	0.006	-0.0053	0.0005	-0.0122
Panicle Length	0.0024	-0.0019	0.0299	0.0042	0.0084	0.0064
No. of leaves/ plant	-0.027	0.016	0.0396	0.2826	0.0581	0.0828
Leaf Length	-0.0221	0.0002	-0.0125	-0.0091	-0.0442	-0.0212
Leaf width	-0.0111	0.0485	0.0806	0.1101	0.1799	0.3757
Fodder yield/ Plant	0.1064	0.0411	0.1565	0.3673	0.2818	0.4269
Partial R²	0.0169	0.0039	0.0047	0.1038	-0.0125	0.1604

Residual effect = 0.8502

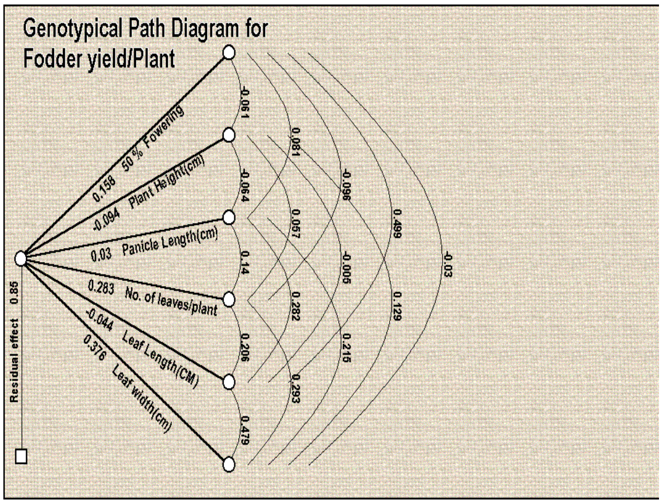


Fig. 1- Direct, indirect and residual effects of different traits on fodder yield

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Table 4- Range and characters mean of top five accessions over two year in the land races of forage sorghum

Characteristics	Range	Mean	Five best entries and their pooled mean over two year
50% Flowering	38.00-105.5	84.83	EG-35 (46.0), E-186 (46.0), ERN-13 (44.5), E-143 (42.5), EJN-11 (38.0)
Plant Height	121.00-302.25	220.23	EA-2 (302.25), GUB-50 (300.75), EJN-26 (297.0), ERN-29 (292.5), GGUB-56 (291.75)
Panicle Length	4.00-36.50	16.25	E-186 (36.5), GGUB-47 (33.0), E-153 (31.0), ERS-25 (28.5), EB-2 (23.0)
No. of leaves/plant	6.00-20.50	14.98	ERN-11 (20.5), E-159 (20.0), GGUB-32 (20.0), GGUB-47 (19.0), GGUB-30 (19.0)
Leaf Length	37.50-103.50	76.92	EB-2 (103.5), E-159 (99.0), GGUB-57 (99.0), E-195 (98.0), EG-40 (94.0)
Leaf width	2.75-9.25	5.72	GGUB-47 (9.3), E-159 (9.0), GGUB-52 (8.5), E-186 (8.3), E-197 (7.8)
Fodder yield/Plant	0.116-0.512	0.24	E-203 (0.5125), GGUB-39 (0.512), EG-40 (0.438), E-1 (0.4165), GGUB-19 (0.4125)