Annals of Plant and Soil Research 18(3): 257-261 (2016)

GENETIC VARIABILITY IN PARENTS AND CROSSES OF DUAL SORGHUM

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Received: May, 2016; Revised accepted: August, 2016

ABSTRACT

Significant variation were recorded among nine parents and 36 crosses of sorghum (Sorghum bicolor (L.) Moench) for various morphological and yield traits developed at Sorghum Research Station, S. D. Agricultural University, Deesa, Gujarat during Kharif 2015-16. The phenotypic coefficients of variation (PCV) were higher than the genotypic coefficients of variation (GCV) for all the traits under investigation. High magnitude of genotypic and phenotypic coefficient of variations was observed for dry fodder yield and grain yield per plant. Estimates of heritability varied from 7.76% (leaf width) to 95.25% (fodder yield / plant). The association of high heritability with high genetic advance and GCV was reported in case of dry fodder yield, plant height and grain yield / plant. Grain yield /plant was significantly and positively correlated with panicle length while fodder yield was positively correlated with days to 50 % flowering, days to maturity, plant height, number of leaves /plant, leaf length and leaf width. Path coefficient analysis revealed as high direct effects of panicle length on grain yield /plant. Whereas, number of leaves /plant, plant height, leaf length, days to maturity and days to 50% flowering exerted positive and high direct effects on dry fodder yield /plant. Studied characters should be balanced for selecting high seed and fodder yielding genotypes.

Keywords: Sorghum, heritability, genotypic coefficient of variation, phenotypic coefficient of variation, correlation, path analysis

INTRODUCTION

Sorghum (*Sorghum bicolor* (L.). Moench) is an important food and fodder crop of dry land agriculture. It has wide range of adaptability to various agro ecological situations of the region. It is the fifth most important food crop after wheat, rice, maize, and barley and is widely grown in the semi-arid regions of India. India is the fifth largest sorghum producer with 5.82 million hectares of area under sorghum cultivation, and with a total production of 5.39 million tonnes (FAOSTAT, 2014). Sorghum is more tolerance to high temperature and better ability to stand during drought conditions. The estimate of genetic parameters for different traits and their association is important for successful breeding programme. 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 is simply a standardized partial regression coefficient which splits the correlation coefficient into the measures of direct and indirect effects. It measures the direct and indirect contribution of independent variables on dependent variable. Therefore, the present study was undertaken to estimate the variability in newly generated sorghum breeding materials.

MATERIALS AND METHODS

Forty six sorghum genotypes including 9 parents and 36 newly developed F_1s were used for the present study. The trial was grown in randomized block design with 2 replication at Sorghum Research Station, Sardarkrushinagar Dantiwada Agricultural University, Deesa (Gujarat) during Kharif 2015. 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 having good physical and chemical properties (organic carbon 2.3 g kg^{-1} EC 0.23 dSm^{-1} available K 259 and P_2O_5 46.2 kg

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ha^{-1}). The experimental unit was a single-row plot of 4.0 m long, spaced at 0.45 m apart. NPK 120:60:00 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 all other recommended agronomical practices were followed to raise a good crop during the season. Data were taken on days to 50 % flowering, plant height, number of leaves /plant, leaf length, leaf width, panicle length, dry fodder yield /plant and grain yield /plant. Statistical analysis was done according to the standard statistical procedures (Burton, 1952; Johnson et al., 1955; Al-Jibouri et al., 1958 and Dewey and Lu, 1959).

RESULTS AND DISCUSSION

The analysis of variance revealed highly significant ($p<0.01$) differences among all the parents and crosses for days to 50 % flowering, plant height, number of leaves /plant, leaf length, leaf width, panicle length, dry fodder yield per plant and grain yield per plant (Table 1) .

Table 1: Analysis of variance for nine characters in Sorghum

Parameters	DF	Days to 50% flowering	Days to maturity	Plant height	No. of leaves/ plant	Leaf length	leaf width	Panicle length	Seed yield/plant	Fodder yield/plant
Replications	1	5.38	16.04	2788.90	3.21	0.71	0.10	0.10	16.10	6987.21
Treatments	44	77.91**	87.78**	4034.85**	6.36**	39.58**	2.79**	24.22**	1208.92**	52787.54**
Error	44	3.79	3.23	597.83	0.53	3.98	0.33	2.33	96.95	1217.76

, significant at 5% and 1% respectively*

High magnitude of variation for the experimental material was also reflected by wider range for all the traits under study (Table 2). This suggested adequate amount of variability among the materials that may be helpful for trait improvement and selection. These results are in agreement with the findings of Gobharle et al. (2010), Jain and Patel (2014). The genetic constants for the characters revealed that the magnitude of phenotypic coefficient of variation (PCV) was higher than the corresponding genotypic coefficient of variation (GCV) for all the traits denoting environmental factors influencing their expression to some degree or other. Wide differences between PCV and GCV for number of leaves per plant, leaf width, days to maturity, leaf length and days to 50% flowering implied their susceptibility to environmental fluctuation, whereas narrow differences between PCV and GCV for fodder yield per plant, grain yield per plant, panicle length and plant height suggested their relative resistance to environmental alterations. High magnitude of genotypic and phenotypic coefficient of variations (%) was observed for fodder yield per plant (56.63, 58.02) and grain yield per plant (40.08, 43.71) where as moderate to lower variation was observed for remaining traits. High values of GCV and PCV suggested that there is a possibility of improvement

Table 2: Estimates of mean, range, coefficient of variability, heritability and genetic advance for different characters in Sorghum

Character	Mean	Standard Deviation	Range	CV	GCV	PCV	Heritability	Genetic advance	Genetic advance % Mean
Days to 50% flowering	73.06	7.35	64.0-84.5	2.64	6.79	10.11	45.12	6.86	9.39
Days to maturity	103.53	9.61	94.5-121.5	1.71	3.82	9.32	16.79	3.34	3.22
Plant height	262.00	53.75	209.2-412.5	9.25	16.65	20.59	65.39	72.67	27.74
Leaves/plant	12.77	3.17	9.8-18.0	5.54	12.01	24.72	23.62	1.54	12.03
Leaf length	85.53	6.96	76.6-98.3	2.40	4.45	8.16	29.71	4.27	4.99
leaf width	9.01	3.24	7.5-10.1	6.50	10.01	35.95	7.76	0.52	5.75
Panicle length	25.96	3.81	18.4-33.2	6.05	12.96	14.75	77.21	6.09	23.45
Seed yield/plant	58.60	25.48	16.0-161.0	16.61	40.08	43.71	84.07	44.37	75.71
Fodder yield/plant	285.87	165.25	110.0-775.0	12.14	56.63	58.02	95.25	325.47	113.86

through direct selection for the seed and fodder yields. While for days to 50% flowering and maturity, number of leaves per plant, leaf length, leaf width, plant height and panicle length, the estimate of both the genotypic and phenotypic coefficients of variation were moderate to low, indicated that improvement for these traits can be achieved up to some extent. These results are in accordance with the findings of Mahajan *et al.,* (2011).

The estimate of GCV and PCV alone is not much helpful in determining the heritable portion. The amount of advance to be expected from selection can be achieved by estimating heritability along with coefficient of variability. Burton (1952) also suggested that GCV and heritability estimate would give better information about the efficiency of selection. In this case, maximum heritability was recorded for fodder yield per plant (95.25 %), grain yield per plant (84.07%) and panicle length (77.21 %). Whereas, medium to minimum estimate for heritability was observed by plant height (65.39 %), days to 50% flowering (45.12 %), leaf length (29.71%), number of leaves per plant (23.62%), days to maturity (16.79%) and leaf width (7.76%). The high degree of heritability estimates for most of the traits suggested that the characters are under genotypic control. High heritability coupled with high genetic advance and GCV were noticed for dry fodder yield/plant, seed yield per plant and plant height. This indicated the importance of the considerable additive (heritable) gene effect in governing their inheritance and phenotypic selection for their improvement could be achieved by simple method like pure line or mass selection or pedigree and bulk method following hybridization and selection in early generations. These results are accordance with the findings of earlier workers (Sharma *et al.,* 2006 and Jain *et al.,* 2013 and Jain and Patel. 2014).

Table 3: Estimation of phenotypic and genotypic correlation between different characters in Sorghum

Characters		Days to 50% flowering	Days to maturity	Plant height	Number of leaves/plant	Leaf length	leaf width	Panicle length	Seed yield/plant
Days to maturity	G	0.701**							
	P	0.813**							
Plant height	G	0.069^{NS}	0.245*						
	P	0.297**	0.400**						
Leaves/plant	G	1.075**	1.405**	0.682**					
	P	-0.234*	-0.467**	-0.055^{NS}					
Leaf length	G	-0.167^{NS}	-0.371**	0.789**	0.977**				
	P	0.457**	0.626**	0.659**	-0.414**				
leaf width	G	1.298**	1.947**	-0.318**	-0.353**	0.721**			
	P	-0.408**	-0.623**	-0.433**	0.751**	-0.623**			
Panicle length	G	-0.363**	-0.397**	-0.288**	-0.660**	-0.328**	0.222*		
	P	-0.398**	-0.370**	-0.287**	-0.052^{NS}	-0.348**	0.298**		
Seed yield/plant	G	-0.229*	-0.230*	-0.146^{NS}	-0.457**	-0.408**	-0.036^{NS}	0.609**	
	P	-0.066^{NS}	0.025^{NS}	-0.069^{NS}	-0.298**	-0.116^{NS}	-0.114^{NS}	0.482**	
Fodder yield/plant	G	0.441**	0.650**	0.820**	0.751**	0.800**	-0.259*	-0.402**	-0.211*
	P	0.324**	0.314**	0.659**	0.302**	0.466**	-0.137^{NS}	-0.352**	-0.186^{NS}

, significant at 5% and 1% respectively*

The genotypic and phenotypic correlation coefficients among different characters including grain and dry fodder yield per plant revealed that phenotypic correlation coefficient was varied from genotypic correlation coefficient (Table 3). The correlation coefficients at genotypic level were generally of higher magnitude than the corresponding phenotypic level, indicating the inherent/heritable relationship where as phenotypic correlation was higher than the genotypic correlation coefficients, which may be a result of modifying effect of environments on the association of the characters. Grain yield per plant was strongly correlated with panicle length. Whereas, the dry fodder yield per plant was positively and significantly correlated with plant height, number of leaves per plant, leaf length, days to maturity and days to 50% flowering. These results are in agreement with the findings of Jain *et al.* (2010), Arunah *et al.* (2015) and Khandelwal *et al.* (2015).

Table 4: Estimation of direct and indirect effects of yield components on seed yield per plant based on path Coefficient analysis in Sorghum

Characters	Days to 50% flowering	Days to maturity	Plant height	Number of leaves/plant	Leaf length	leaf width	Panicle length	Fodder yield/plant
Days to 50% flowering	-0.021	0.135	0.033	0.067	-0.155	0.042	-0.199	0.033
Days to maturity	-0.017	0.166	0.044	0.134	-0.213	0.064	-0.185	0.032
Plant height	-0.006	0.066	0.111	0.016	-0.224	0.045	-0.144	0.068
Number of leaves/plant	0.005	-0.077	-0.006	-0.288	0.141	-0.077	-0.026	0.031
Leaf length	-0.010	0.104	0.073	0.119	-0.340	0.064	-0.174	0.048
Leaf width	0.009	-0.103	-0.048	-0.216	0.212	-0.103	0.149	-0.014
Panicle length	0.009	-0.061	-0.032	0.015	0.118	-0.031	0.500	-0.036
Fodder yield/plant	-0.007	0.052	0.073	-0.087	-0.158	0.014	-0.176	0.103

Residual effects: 0.64328

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 4 and Table 5) is done to partition the correlation coefficients in to direct and indirect effects. Seed yield and fodder yield per plant were taken as dependent variable while computing the path coefficient. The results on path coefficient analysis revealed positive correlation as well as high or moderate direct effects of panicle length on grain yield per plant. Negative correlation and low direct effects of plant height, and fodder yield per plant on grain yield was also observed in this study. The high residual effect (0.643) indicated that further study should be done with other yield component like 1000-grain weight, harvest index and panicle width (Table 4). The path coefficient analysis for dry fodder yield per plant revealed that the characters like number of leaves per plant, plant height, leaf length, days to maturity and days to 50% flowering which had positive significant association with green fodder yield also exerted positive and high direct effects on dry fodder yield per plant (Table 5). This confirms the role of these traits in determining the dry fodder yield and therefore, their values in constructing the selection criterion (Nayak *et al.* 2016).

Table 5: Estimation of direct and indirect effects of yield components on fodder yield per plant based on path Coefficient analysis in Sorghum

Characters	Days to 50% flowering	Days to maturity	Plant height	Number of leaves/plant	Leaf length	leaf width	Panicle length	Seed yield/plant
Days to 50% flowering	0.051	0.117	0.104	-0.162	0.128	0.086	0.003	-0.004
Days to maturity	0.041	0.144	0.140	-0.322	0.175	0.131	0.003	0.001
Plant height	0.015	0.058	0.351	-0.038	0.184	0.091	0.002	-0.004
Number of leaves/plant	-0.012	-0.067	-0.019	0.691	-0.116	-0.158	0.000	-0.017
Leaf length	0.023	0.090	0.231	-0.286	0.280	0.131	0.003	-0.006
leaf width	-0.021	-0.090	-0.152	0.518	-0.174	-0.211	-0.003	-0.006
Panicle length	-0.020	-0.053	-0.101	-0.036	-0.097	-0.063	-0.009	0.027
Seed yield/plant	-0.003	0.004	-0.024	-0.206	-0.032	0.024	-0.004	0.055

Residual effects: 0.34660

It may be concluded from the resuls that high emphasis should be given on dry fodder yield/plant, grain yield per plant, plant height and panicle length, as they posses high heritability coupled with genetic advance indicating more gain of selection in next generation. Apart from this, results from both correlation and path coefficient analysis indicated that panicle length should be balanced for selecting high grain yielding genotypes in sorghum While, different characters viz., plant height, number of leaves per plant, leaf length, days to maturity and days to 50% flowering should considered for selecting the high fodder yielding genotypes.

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