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GENETIC VARIABILITY, CHARACTER ASSOCIATION AND PATH ANALYSIS STUDIES IN SORGHUM (*SORGHUM BICOLOR* L. MOENCH)

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ABSTRACT

Experiment was conducted to study the genetic variability, association among the yield component traits, their direct and indirect effects on the yield of sorghum. All the genotypes showed considerable amount of variation in their mean performances with respect to the characters studied, indicates presence of sufficient variability and scope for further selection and breeding superior and desirable genotypes.GCV played a major role for the expression of the traits. Fodder yield/plant (34.08) had high GCV, followed by Grain yield/Ha (29.88), Grain yield/plant (28.48), Ear head length (12.89), Test weight (11.04), Seed set % (10.25), Plant Height (9.05), Days 50% flowering (8.35) and Ear head breadth (8.27). Heritability in narrow sense ranged from 50.30 (ear head breadth) to 92.20 (grain yield). High GA observed for grain yield (1376.74) coupled with high heritability (92.20), indicating the preponderance of the non-additive gene action; suggesting that hybridization breeding will be effective. Ear head length (0.443) and seed set % (0.705) were positively associated with grain yield per hectare indicating any increase in these traits will increase the yield. Ear head length, test weight and seed set percent had positive direct effect on yield indicating importance of these characters, which can be strategically used to improve the yield of sorghum.

INTRODUCTION

Sorghum bicolor is the important cereal grain on world's production basis after wheat, maize, rice and barley. Among cereals, it occupies third position in respect of area and production. Its importance is ever increasing as the source of food for rural masses, food for teeming cattle population and raw material for the industries. Also with the present scarcity situation sorghum cultivation is the heart of dry land agriculture, being C4 plant it can utilize sunlight and water efficiently. It is unique to adapt to environmental extremes of a biotic and biotic stresses.

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. 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 genetic variability, relationships among quantitative traits and Path coefficient analysis in selected genotypes of sorghum during Rabi 2009-10.

MATERIALS AND METHODS

The experimental material for the present investigation comprised SPV 1887, SPV 1888, SPV 1889, SPV 1890, SPV 1891, SPV 1892, SPV 1893, SPV 1894, SPV 1895, SPV 1896, SPV 1897, SPV 1898, SPV 1899, SPV 1900, SPV 1901, SPV 1902, SPV 1903, SPV 1904, SPV 1905, SPV 1906, SPH 1647, SPH 1648 with DSV 4 and Five local checks of *Sorghum bicolor* (L.) Moench. These 28 genotypes were grown at the Agricultural Research station, Raddewadgi, Taluka-Jewargi of District- Gulabarga (Karnataka) during rabi 2009 with a spacing 45 cm x 15 cm. The experiment was laid out in randomized block design with three replications. Observations were recorded on five competitive plants in each genotype in each replication for Days to 50 per cent flowering, Plant height, Ear head length, Ear head breadth, Seed set percent, Test weight, Grain yield and ,Fodder yield per plant. The mean values were used for statistical analysis. The data was analyzed statistically for genotype and phenotype coefficients of variation (Burton, 1952), Heritability (Allard, 1960) and genetic advance (Johnson *et al.*, 1955).The genotypic and phenotypic correlation co-efficient, path co- efficient analysis was done to partition the genotypic correlation co-efficient into direct and indirect effects. Knowledge of the relationship among yield components is essential for the formulation of breeding programme aimed at achieving the desired combinations of various components of yield. The estimates of correlation coefficients among the different characters indicate the extent and direction of association. The correlation co-efficient provide a reliable measure of association among the characters and help to differentiate vital associations useful in breeding from those of the non-vital ones (Falconer, 1981).

RESULTS AND DISCUSSION

The success of plant breeding programs relies heavily on the existence of genetic variability in plants for a particular trait. Estimates of mean sum of squares for replications and genotypes and CV % for the studied genotypes are shown in Table 1.The analysis of variance revealed that the significant differences among genotypes for all characters, which indicated presence of variability among the lines being evaluated and ample scope of improvement by selection. Similar results were observed by Arunkumar *et al*. (2004) and Chavan *et al*. (2010).

Genotypic and Phenotypic Variation

The range of variation and the estimate of genetic parameters which include heritability in broad sense, coefficient of variation (GCV and PCV) and genetic advance are presented in Table 2. The PCV was higher than GCV for all the characters studied showing that all the traits were highly influenced by environment. However differences between them were not of high magnitude. The range was highest for grain yield per hectare (348.50 - 3804.71) followed by Plant Height (145.20 - 237.00), Fodder yield/plant (47.10 - 189.99).days to 50 per cent flowering (66.00 - 96.00), Seed set percent (50.00 – 100.00), Ear head length (12.60 - 26.80) and lowest range was Test weight (2.01 - 3.81) and Ear head breadth (4.20 – 7.20). High estimates of GCV and PCV were observed for fodder yield (34.08, 35.52), grain yield/ha (29.88, 31.11) and grain yield/plant (32.65, 28.48). Low GCV and PCV were noticed for ear head breadth (8.27, 11.67), days to 50% flowering (8.35, 9.26), plant height (9.05, 10.75) and also for seed set percent (10.25, 11.50). Similar results were observed by Jain and Patel (2012). The effectiveness of selection for any character depends, not only the extent of genetic variability but also in the extent to which it will be transferred from one generation to the other generation. High heritability was observed for grain yield/ha (92.20) followed by grain yield/ plant (87.30) and fodder yield per plant (92.10).Moderate heritability was observed for days to 50% flowering (81.30), seed set percent ( ) 79.40, plant height (71.00) and test weight (69.60). Chavan *et al*. (2010) and Godbharle *et al*, (2010) recorded similar observations. However, low heritability was recorded for ear head length (61.20) and breadth (50.30) in the present study. These results are in accordance with Godbharle *et al*, (2010).High and low genetic advance was observed for grain yield/ha (1376.74) and test weight (0.60) respectively. High heritability coupled with high genetic advance was recorded for grain yield/ha (92.20) and fodder yield/ha (92.10) revealing that characters are governed by additive gene action and phenotypic selection for these characters will be effective. High heritability and high genetic advance for grain yield per hectare and fodder yield have been reported by Roa and Patil (2006).

Correlation

Correlation coefficient is a statistical measure, which denotes the degree and magnitude of association between any two casually related variables. This association is due to pleiotropic gene action or linkage or more likely both. In plant breeding correlation coefficient analysis measures the mutual relationship between two characters and it determines character association for improvement yield and other economic characters. Since the association pattern among yield components help to select the superior genotypes from divergent population based on more than one interrelated characters. Thus information on the degree and magnitude of association between characters is of prime important for the breeder to initiate any selection plan. In general the genotypic

Table 1: Mean Sum of Squares for Characters in Sorghum

Characters	Replication	Treatment	Error	S.Em. ±	CV (%)
Days 50% flowering	0.47	126.25**	9.01	2.45	4.01
Plant Height cms	441.63	956.79**	114.77	8.75	5.79
Ear head length (cm)	1.83	20.54**	3.58	1.55	10.26
Ear head breadth (cm)	0.37	0.80**	0.20	0.36	8.23
Seed set percent (%)	78.31	309.84**	24.72	4.06	5.22
Test weight(100seeds) in grams	0.13	0.41**	0.05	0.19	7.29
Grain yield/plant (grams)	4.01	96.32**	4.46	1.72	10.87
Fodder yield/plant (grams)	123.16	3058.13**	85.17	7.54	9.99
Grain yield/Ha (Kgs)	17920.00	1493864.70**	40863.78	165.05	8.68

Table 2: Mean and other Variability Parameters for Characters in Sorghum

Traits	Mean	Range		GCV	PCV	h^2	GA	GAM
		Min	Max					
Days 50% flowering	74.89	66.00	96.00	8.35	9.26	81.30	11.61	15.50
Plant Height cms	185.02	145.20	237.00	9.05	10.75	71.00	29.08	15.72
Ear head length (cm)	18.45	12.60	26.80	12.89	16.47	61.20	3.83	20.76
Ear head breadth (cm)	5.42	4.20	7.20	8.27	11.67	50.30	0.66	12.17
Seed set percent (%)	95.15	50.00	100.00	10.25	11.50	79.40	17.89	18.80
Test weight(100seeds) in grams	3.14	2.01	3.81	11.04	13.23	69.60	0.60	19.08
Grain yield/plant (grams)	19.43	7.41	32.65	28.48	30.48	87.30	10.65	54.81
Fodder yield/plant (grams)	92.36	47.10	189.99	34.08	35.52	92.10	62.23	67.37
Grain yield/Ha (Kgs)	2329.45	348.50	3804.71	29.88	31.11	92.20	1376.74	59.10

Table 3: Phenotypic and Genotypic Correlation Coefficient between different traits in Sorghum

Traits		Days 50% flowering	Plant Height (cms)	Ear head length (cms)	Ear head Breadth (cms)	Seed set percent	Test weight (grams)	Grain yield/plant (grams)	Fodder yield/plant (grams)	Grain yield /Ha(Kgs)
Days 50% flowering	G	1	0.174	-0.362	0.605**	-0.678**	0.325	-0.358	0.846**	-0.673**
	P		0.158	-0.302	0.374	-0.569**	0.242	-0.283	0.729**	-0.547**
Plant Height(cms)	G		1	0.006	-0.231	-0.212	-0.027	-0.037	0.129	0.029
	P			-0.019	-0.116	-0.151	0.011	-0.009	0.061	0.047
Ear head length(cms)	G			1	-0.284	0.176	0.029	0.434*	-0.093	0.443*
	P				-0.126	0.117	0.109	0.361	-0.025	0.318
Ear head breadth(cms)	G				1	-0.183	0.019	0.219	0.529**	0.449*
	P					-0.09	0.015	0.166	0.35	0.335
Seed set percent	G					1	-0.21	0.399	-0.526**	0.705**
	P						-0.12	0.322	-0.453*	0.615**
Test weight(grams)	G						1	0.041	0.512**	0.023
	P							0.004	0.397	0.004
Grain yield/plant(grams)	G							1	-0.06	0.311
	P								-0.029	0.276
Fodder yield/plant(grams)	G								1	-0.508**
	P									-0.462*
Grain yield/Ha(Kgs)	G									1
	P									

Table 4: Genotypic and Phenotypic Path Analysis for direct (diagonal) and indirect (off diagonal) effects of yield components on yield in Sorghum

Traits		Days 50% flowering	Plant Height (cms)	Ear head length (cms)	Ear Breadth length (cms)	Seed setpercent	Test weight (grams)	Grain yield/plant (grams)	Fodder yield/plant (grams)	Grain yield/Ha (Kgs)
Days 50%flowering	G	-0.171	0.037	-0.112	0.018	-0.387	0.082	0.041	-0.182	-0.674**
	P	-0.018	0.018	-0.057	-0.07	-0.271	0.03	-0.022	-0.159	-0.549**
Plant Height(cms)	G	-0.03	0.215	0.002	-0.007	-0.121	-0.007	0.004	-0.028	0.028
	P	-0.003	0.116	-0.004	0.022	-0.072	0.001	-0.001	-0.013	0.046
Ear head length(cms)	G	0.062	0.001	0.309	-0.008	0.101	0.007	-0.049	0.02	0.443*
	P	0.005	-0.002	0.189	0.024	0.056	0.014	0.027	0.005	0.318
Ear head breadth(cms)	G	-0.103	-0.049	-0.088	0.029	-0.105	0.005	-0.025	-0.114	-0.450*
	P	-0.007	-0.013	-0.024	-0.187	-0.043	0.002	0.013	-0.076	-0.335
Seed setPercent	G	0.116	-0.045	0.055	-0.005	0.57	-0.053	-0.045	0.113	0.706**
	P	0.01	-0.018	0.022	0.017	0.476	-0.015	0.024	0.099	0.615**
Test weight(grams)	G	-0.056	-0.006	0.009	0.001	-0.12	0.253	0.005	-0.11	-0.024
	P	-0.004	0.001	0.02	-0.003	-0.057	0.126	0	-0.087	-0.004
Grain yield/plant (grams)	G	0.061	-0.008	0.134	0.006	0.227	-0.01	-0.113	0.013	0.31
	P	0.005	-0.001	0.068	-0.031	0.153	0	0.076	0.006	0.276
Fodder yield/plant (grams)	G	-0.145	0.028	-0.029	0.015	-0.3	0.13	0.007	-0.215	-0.509**
	P	-0.013	0.007	-0.005	-0.065	-0.216	0.05	-0.002	-0.218	-0.462*

correlation was generally of higher magnitude than phenotypic correlation (Table 3), indicating that inherent association between various characters studied. In general the genotypic correlation was generally of higher magnitude than phenotypic correlation, indicating that inherent association between various characters studied.

Days to 50% flowering had positive association with ear head breadth (0.605) and fodder yield/plant (0.846) at genotypic and with fodder yield/plant (0.729) at phenotypic level. Seed set % had positive correlation with grain yield per hectare (0.705 and 0.615) at both genotypic and phenotypic levels. Ear head length and Ear head breadth (0.529), Test weight (0.512) is positively associated with grain yield per hectare at genotypic level. The results obtained are similar to the results obtained by Aml, *et al.* (2012) and Godbharle *et al.* (2010)

Days to 50% flowering recorded negative association with seed set percent (-0.678 and -0.569) and grain yield per hectare (-0.673 and - 0.547) at both genotypic and phenotypic levels. Vijaya Kumar *et al*. (2012) also obtained same results. Fodder yield showed negative association with seed set percent (-0.526 and -0.453) and grain yield per hectare (-0.508 and -0.462) at both genotypic and phenotypic levels.

Path analysis

Due to mutual cancellation of component traits, the estimation of correlation alone may be often misleading so it is necessary to study the path co-efficient analysis, which takes into account, the casual relationship in addition to the degree of relationship. Hence genotypic and phenotypic correlation was partitioned into direct and indirect effects to know the relative importance of the components (Table 4). Plant height (0.215, 0.116), ear head length (0.309, 0.189), test weight (0.253, 0.126) and seed set percent (0.570, 0.476) had positive direct effect on yield at both genotypic and phenotypic level, indicating importance of these characters. Similar results were revealed by Aml, *et al.* (2012).

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