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Variability and Character Association Studies in Sorghum Germplasm (*Sorghum bicolor* (L.) Moench)

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ABSTRACT

Variability, correlation and path analysis were carried out for grain yield and yield contributing traits in 122 sorghum accessions. Grain yield/plant showed higher estimates of GCV and PCV followed by fodder yield/plant, panicle weight, panicle length, 100 grain weight and plant height. High heritability coupled with high genetic advance were obtained for plant height, panicle weight, grain yield/plant and fodder yield/plant indicating that these traits are predominantly under the control of additive gene action and hence, these characters can be improved by selection. Correlation studies revealed that grain yield per plant was positively and significantly associated with days to 50 per cent flowering, panicle length, panicle weight, and 100 grain weight indicating the importance of these traits in developing high yielding sorghum varieties. Further, path analysis revealed high direct effect of panicle weight for grain yield/plant along with considerable high positive indirect effect *via* panicle length followed by 100 grain weight indicating the importance of these characters during selection for high yield

Key words: *Correlation, Germplasm, Path coefficient analysis, Variability.*

Sorghum is one of the major cereal crops of the semi-arid tropics and is cultivated in more than 100 countries, out of which 59 per cent of world sorghum area is in Africa and 25 per cent is in Asia. A large amount of variation is necessary in a breeding population to enable the breeder to carry out effective breeding program. Quantitative characters are not only polygenically controlled but also considerably influenced by the fluctuating environmental conditions. The study of relationships among quantitative traits is important for assessing the feasibility of joint selection of two or more traits. A positive genetic correlation between two desirable traits makes the job of the plant breeder easy for improving both traits simultaneously. Knowledge of the relationship among yield components is also essential for achieving the desired combinations of various yield components. Path coefficient analysis measures the direct influence of one variable upon the other and permits separation of correlation coefficient into components of direct and indirect effects and aids in the identification of effective selection criteria. In this context, an attempt was made to study the variability, correlation and path analysis in 122 germpalsm accessions of sorghum.

MATERIAL AND METHODS

The experimental material consisted of 122 accessions of sorghum collected from International Crop Research Institute for Semi Arid Tropics (ICRISAT), Hyderabad; Indian Institute of Millet Research (IIMR), Hyderabad and Regional Agricultural Research station (RARS), Nandyal. Among these 122 accessions, ninety five were land races, ten were exotic collection, two were improved varieties and the remaining 15 accessions were R-lines (Table 1). The experimental sorghum accessions were raised in a two rows of 4 m length with two replications in randomized block design at Agricultural College Farm, Bapatla during *Rabi* 2015-16 by adopting a spacing of 45 cm × 15 cm. All the recommended agronomic packages of practices were adopted during the crop period. In each replication, five random plants were chosen and the observations were recorded on seven quantitative traits *viz.*, days to 50 per cent flowering, plant height (cm), panicle length (cm), panicle weight (g), 100 grain weight (g), grain yield per panicle (g) and fodder yield/plant (g) at the time of maturity except, days to 50 per cent flowering which was recorded on plot basis. The mean values were utilized for statistical analysis to assess the genetic diversity among the accessions.

Analysis of variance was carried for all the seven quantitative traits using procedure described by Singh and Chaudhary (2010). Further, correlation co-efficients were worked following the method of Al-Jibouri *et al*. (1958). Path co- efficient analysis was carried out as suggested by Dewey and Lu (1959).

RESULTS AND DISCUSSION

Descriptive Statistic

Statistical analysis was carried out with the data on seven quantitative traits to assess the quantitative trait variability pattern (Table 2). The range was highest for plant height (72 cm - 217.1 cm)

Table 1. Details of experimental material studied in the present investigation

S.No.	Source	No. of genotypes	Genotypes studied
1	International Crop Research Institute for Semi Arid Tropics (ICRISAT), Hyderabad;	12	ICSV – 12002,ICSR -98, ICSR -40, ICSR -196, IS – 33722, IS-25680, ICSV – 12003, IS 3436, IS – 18700, IS – 18463, ICSV – 12001, IS -26871
2	Indian Institute of Millet Research (IIMR), Hyderabad	70	EP 3, EP -19, EP -102,EP – 103, EC -582511, EP- 130, EG – 28, EG – 35, EC – 4701, EC -582508, EP – 86, EC -3, EC -24, EC 22, EC -26, EC -28, EP -53, EC -13, EC -5, EC -34, EP -79, EP – 57, EP -65, EP -75, EG -31, EP – 129 EP -59, EP -60, EP -62, EP -67, EP -70, EP -72, EP-74, EP -78, EP -81, EP -82, EP -84, EP -87, EP -92, EP -93,EP -94, EP -95, EP -97,EP -98, EP -99, EP -104, EP -106, EP -107, EP -109, EP -111, EP -112, EP -113, EP -115, EP -117, EP -120, EG -42, EC – 582510, EP – 131EP – 135,PEC – 1, PEC – 2, PEC – 4,PEC – 8, PEC – 13,PEC – 33, SEVS -3, SEB -12000,SEB -12009, SEB 12024
3	Regional Agricultural Research station (RARS), Nandyal	40	GP(W) 2620, HDW – 443, 4515, 23521, 2072, 27697, AR 233, GP (W) 2394-1, GP –(W) 2375, GP –(W) 296, GP (W) 2635, GP (W) 2638, GP (W)- 2636, GP (W)- 2627, GP (W) 2630, P1195682, YSC 1850, P175116, P1248305, Agros -2650, VKG -34137, PVK -801, 2-2-2-9, 4- 1-7-3, R -20, R -29, R -49, R -64, R -75, R -172, R -89035, R- 91011, R -91012, R -91014, R -91019, R -3777, RS -627, HPT -8, RMHPT -18, I-33

Table 2. Mean, variability, heritability and genetic advance for grain yield and yield components in Sorghum

Character	Mean	Range		Coefficient of variation (%)		Heritability (broad sense)	Genetic advance
		Mini-mum	Maxi-mum	GCV	PCV		
Days to 50 per cent Flowering	56.70	45.00	79.00	9.76	10.08	93.83	11.05
Plant height (cm)	130.95	72.00	217.10	21.59	22.14	95.24	56.84
Panicle Length (cm)	18.45	7.00	29.05	28.80	26.17	71.62	4.40
Panicle weight (g)	31.22	3.85	86.70	49.99	50.68	97.49	31.75
100 grain Weight (g)	2.70	1.31	4.72	24.05	24.41	97.18	1.32
Grain Yield/ Plant (g)	16.04	3.40	61.53	74.64	76.18	95.92	24.17
Fodder yield/ plant (g)	35.88	8.00	86.00	50.83	51.66	97.01	37.04

Table 3. Correlation coefficients between grain yield and its component traits in sorghum

Particulars	Days to 50 per cent flowering	Plant height	Panicle length	Panicle weight	100 grain weight	Yield/plant	Fodder yield/Plant
Days to 50 per cent flowering	1	-0.223**	0.121	0.224**	0.155*	0.213**	0.136*
Plant height		1	-0.235**	-0.324**	-0.137*	-0.271**	0.106
Panicle length			1	0.542**	0.254**	0.436**	0.038
Panicle weight				1	0.303**	0.737**	0.210**
100 grain weight					1	0.321**	0.128*
Grain yield/plant						1	0.360**
Fodder yield/Plant							1

*, **Significant at 5 and 1 per cent levels respectively

Table 4. Path coefficients of yield components on grain yield per plant in sorghum germplasm

Particulars	Days to 50 per cent flowering	Plant height	Panicle length	Panicle weight	100 grain weight	Fodder yield per Plant	Correlation with grain yield/plant
Days to 50 per cent flowering	0.011	0.016	0.007	0.136	0.013	0.031	0.213**
Plant height	-0.002	-0.071	-0.014	-0.197	-0.011	0.024	-0.271**
Panicle length	0.001	0.017	0.059	0.329	0.021	0.009	0.436**
Panicle weight	0.002	0.023	0.032	0.608	0.025	0.047	0.737**
100 grain weight	0.002	0.01	0.015	0.184	0.082	0.029	0.321**
Fodder yield per Plant	0.001	-0.008	0.002	0.128	0.011	0.225	0.360**

*, **Significant at 5 and 1 per cent levels respectively; Residual Effect: 0.39

followed by panicle weight (3.85- 86.7).The estimate of genotypic coefficient of variation (GCV) was lower than phenotypic coefficient of variation for all the traits studied indicating the effect of environment. However, the differences between PCV and GCV were low, indicating that the characters studied in the present investigation are mostly under genetic control and less influenced by environment. Among the characters under study, grain yield/plant showed higher estimates of GCV (74.64) and PCV (76.18) followed by fodder yield/plant. Panicle weight, panicle length, 100 grain weight and plant height also recorded high GCV and PCV, indicating the effectiveness of simple selection for improvement of these characters. Similar results were reported earlier by Bhagasara *et al.* (2017) for grain yield/plant, panicle length and 100 grain weight; Badigannavar *et al.* (2017) for plant height; and Rekha Chittapur and Biradar (2015) for panicle weight. However, low GCV (9.76) and PCV (10.08) values were recorded in the present investigation for days to 50 per cent flowering. Similar results were reported earlier by Ranjith *et al.* (2017).

Heritability is a good index for transmission of characters from parents to their offspring. In the present study high estimates of heritability were recorded for all the characters. High heritability noticed for all traits studied suggesting the presence of high component of heritable portion of variation that can be exploited by breeders in selection of superior genotypes on the basis of phenotypic performance. These findings are in consonance with the reports of Mohamad *et al.* (2017) for plant height, panicle length and panicle weight. Further, genetic advance is a useful indicator of the progress that can be expected as result of exercising selection on the pertinent population. High heritability coupled with high genetic advance would therefore give a more reliable index of selection value (Johnson *et al.*, 1955). High values of heritability along

with low value of genetic advance were observed for the characters like panicle length and 100 seed weight indicating that these characters are mainly governed by non additive component of variation, which is non fixable. Heterosis breeding is suggested for improvement of these characters. High heritability coupled with moderate genetic advance was obtained for days to 50 per cent flowering in the present study indicating the role of both additive and non additive gene action in its inheritance. High heritability coupled with high genetic advance was noticed for plant height, panicle weight, grain yield/plant and fodder yield/plant indicating that these traits are predominantly under the control of additive gene action and hence, these characters can be improved by simple selection. Similar observations were made earlier by Badigannavar *et al.* (2017) for plant height in sorghum.

Correlation Analysis

The correlation coefficients of seven quantitative traits estimated are presented in Table 3. Grain yield per plant showed positive and significant association with days to 50 per cent flowering (0.213**), panicle length (0.436**), panicle weight (0.737**), 100 grain weight (0.321**) and fodder yield/ plant. The findings are in conformity with the reports of Arunah *et al.* (2015) who had reported high positive and significant correlation for panicle weight and hundred-seed weight with yield/plant; and Sinha and Kumaravadivel (2016) and Salih *et al*. (2015) for straw yield and yield/plant. Hence, selection for panicle length, panicle weight and 100 seed weight will be helpful for simultaneous improvement of grain yield per plant. Among the yield component traits, the character, days to 50 per cent flowering showed significant and positive association with panicle weight (0.224**), 100 grain weight (0.155*) and fodder yield per plant (0.136*). Similar positive and significant association between days to 50 per cent flowering and fodder yield per plant was reported by Kalpande *et al*. (2015). Thus selection for days to 50 per cent flowering would also aid in the simultaneous improvement of fodder yield per plant. However, plant height exhibited negative and significant correlation with days to 50 per cent flowering (-0.223**), panicle length (-0.235**), panicle weight (-0.324**), 100 grain weight (-0.137**) and grain yield per plant (-0.271**). Similar negative and significant correlation between plant height with hundred grain weight was reported by Jimmy *et al.* (2017) and with panicle length by Zinzala *et al.* (2018).

Panicle length exhibited positive and highly significant association with panicle weight (0.542**), 100 grain weight (0.254**), grain yield per plant (0.436**). So for the development of high yielding varieties in sorghum, panicle length should be considered during selection. The character, 100 grain weight exhibited positive and significant correlation with days to 50 per cent flowering (0.155**), panicle length (0.254**), panicle weight (0.303**), yield per plant and fodder yield per plant (0.128**), indicating scope for simultaneous improvement of these traits.

Path analysis

Path study partitions the total correlation coefficient into direct and indirect effects and measures the relative importance of the causal factor individually. In the present study, grain yield was considered as dependent character and other characters were taken as independent characters. The results of path analysis are presented in Table 4. The residual effect of path analysis was 0.39 indicating that 61 per cent of variation in grain yield was accounted by the traits studied in the present investigation. Panicle weight (0.608) contributed high direct effect to yield per plant along with considerable high positive indirect effect *via* panicle length followed by 100 grain weight, indicating the importance of these characters for grain yield improvement of sorghum. These results are in agreement with the reports of Kassahun *et al.* (2015) for panicle weight and Deshmukh *et al*. (2018) for panicle length and 100 seed weight. The characters, days to 50 per cent flowering, panicle length, 100 grain weight and fodder yield per plant had low positive direct effect on grain yield. Similar results were reported by Khandelwal *et al.* (2015) for panicle length.

CONCLUSION

Panicle weight was identified as effective selection criteria in the present investigation for improvement of grain yield per plant in the sorghum due to its high GCV, PCV, heritability and genetic advance in addition to positive and significant correlation and high positive direct effect observed on grain yield per plant.

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