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Research Article

Genetic variability and association studies in segregating generation of red sorghum (*Sorghum bicolor* (L.) Moench) population

Papineni Venkata Nirosh¹, A. Yuvaraja^{2*}, K. Thangaraj³ and C. Menaka⁴

^{1,2,3}Department of Plant Breeding and Genetics, TNAU, AC&RI, Madurai-625 104, Tamil Nadu, India

⁴Krishi Vigyan Kendra, Madurai, TNAU, AC&RI, Madurai-625 104, Tamil Nadu, India

*E-Mail: yugenetics@yahoo.com

Abstract

Sorghum is a universal crop grown for its diversified end uses. A total of 250 plants of F_2 generation were evaluated for nine quantitative characters of cross made between Paiyur 2 and Kottathur local 5. The minimum difference was observed between the phenotypic coefficient of variation and genotypic coefficient of variation for all the traits which reveals that the effect of environment was minimum on the expression of the character. High PCV was observed for plant height (20.36%), test weight (23.59%), and single plant yield (44.52%). Low PCV was observed for days to fifty percent flowering (9.80%), days to maturity (6.54%) and number of leaves (7.14%). High heritability accompanied with genetic advance was observed for plant height ($h^2=99.03\%$; GAPM=41.55%), leaf length ($h^2=97.87\%$; GAPM=23.70%), stem diameter ($h^2=94.49\%$; GAPM=27.36%), test weight ($h^2=99.03\%$; GAPM=48.13%), and single plant yield ($h^2=99.57\%$; GAPM=91.33%) and it indicates that the characters are under the additive gene action and suitable for the selection process. Plant height (0.6115) recorded positive significant correlation with single plant yield and hence selection towards the plant height directly improves the yield. Plant height (0.6132) and test weight (0.297) showed positive direct effect on single plant yield which indicates that the selection towards these characters will improve the yield.

Key words

Red Sorghum, variability, heritability, correlation, path analysis.

INTRODUCTION

Sorghum is a polyvalent crop grown for food, feed, and fuel. It occupies a prominent place in arid and semi-arid climates of the world and renowned as the most suitable dryland crop. Due to the rich nutritional profile, it was marked as 'Nutritional Grain' (Aruna *et al.*, 2020). Red Sorghum is rich in 3-deoxyanthocyanin phenolic pigment. Its uniqueness is to withstand the high pH and temperature which was a good proxy to the synthetic food colourant. It is also used in the chocolate and biscuit industry for its astringency property. Red sorghum also acts as a good nutritional supplement to poultry feed compared to maize and soybean. Tamil Nadu occupies around 4.96 l. ha of cultivated land with a production of 4.8 l. t. (USDA, 2019). The present study was conducted to know the genetic variability, heritability, genetic advance, correlation and

path analysis of yield and its components for further improvement.

MATERIALS AND METHODS

The genetic material of the present study comprises of F_2 seeds of cross Paiyur 2 (released variety from RRS, Paiyur) X Kottathur Local 5 (local collection from Trichy district). The evaluation was carried out at Breeding Experimental Farm (09° 96' 75.04" North latitude and 78° 20' 71.66" East longitude) at Agriculture College and Research Institute, Tamil Nadu Agriculture University, Madurai. The seeds were space planted and evaluated for nine quantitative characters viz., days to fifty percent flowering, days to maturity, plant height, the number of leaves, leaf length, leaf width, stem diameter, test weight

and single plant yield during the *kharif*, 2020 by adopting the standard crop management practices. A total of 250 single plants were gauged and data were recorded at appropriate stages of plant growth.

The Phenotypic Coefficient of Variation (PCV) and Genotypic Coefficient of Variation (GCV) were deliberated by acquiring the protocol given by Burton (1952). These estimates are differentiated into high (>20%), medium (10-20%), and low (<10%) (Sivasubramanian *et al.*, 1973). Heritability (h^2) and genetic advance as per cent mean (GAPM) are important sources to interpret the selection response and they were processed by adopting the procedure given by Lush (1940) and Johnson *et al.* (1955), respectively. The association study reveals the direction of selection for developing the better performing genotypes. The correlation was estimated by adopting procedure of Hanson *et al.* (1956) and path analysis was estimated by following the procedure given by Dewey and Lu (1959) using the TNAU STAT software.

RESULTS AND DISCUSSION

The variability in the population acts as the main choice for character improvement. Gauging of existing variation is the first step in formulating any breeding program. The true breeding value can be estimated accurately by differentiating the genetic variance from the phenotypic variance by eliminating the environmental variance. Variance components i.e., PCV, GCV, heritability (h^2), genetic advance and genetic advance per cent mean (GAPM) are calculated for all the characters and tabulated in **Table 1**.

In the present study, the difference between the PCV and GCV was observed as minimum. It concludes that the influence of the environment on the expression of the character was low. A high range of variation was observed for the plant height, test weight, and single plant yield and hence the simple selection process for improvement of these characters can be followed. As moderate level of PCV and GCV was observed for leaf length and stem diameter the selection for these characters was

comparatively less to enable the effective selection process. Naoura *et al.* (2019), Mofokeng *et al.* (2019), Swamy *et al.* (2018), Subramanian *et al.* (2019) and Kavipriya *et al.* (2020) exploited the similar results. Low variability was observed for the days to 50 per cent flowering, days to maturity and the number of leaves where the selection process of these characters was ineffective and can be improved through the specialized breeding procedures. High heritability coupled with genetic advance was observed for plant height, the number of leaves, stem diameter, test weight, and single plant yield. It indicates that the character was under the additive gene action and hence the selection was effective for these traits. High heritability coupled with moderate genetic advance was observed for days to fifty percent flowering, days to maturity, the number of leaves, and leaf width and these traits can be improved by selection during the further generations.

Correlation study is computed to quantify the degree of genetic and non-genetic association between two or more characters (Hallauer and Miranda Filho, 1988). The days to fifty per cent flowering exhibited a positive significant correlation with plant height ($r=0.119$), the number of leaves ($r=0.0298$), leaf width ($r=0.056$) and single plant yield ($r=0.099$) and negatively correlated to leaf length ($r=-0.056$) and test weight ($r=-0.098$) (**Table 2**). The homogenous results were obtained by Umakanth *et al.* 2005. Days to maturity shown a negative significant correlation with leaf length ($r=-0.0179$) and test weight ($r=-0.10$). Plant height exhibits a positive significant correlation with single plant yield ($r=0.6115$) and selection towards the plant height directly improves the yield. Kavipriya *et al.* (2020) obtained the similar results. The number of leaves is positively correlated with all the traits. Leaf length is positively correlated with the test weight ($r=0.062$) and single plant yield ($r=0.092$). Yuvaraja *et al.* (2021) exploited the similar results. Leaf width exhibits significant positive correlation with stem diameter ($r=0.17$) and test weight ($r=0.16$). Stem diameter has positively correlated with the single plant yield ($r=0.03$). Test weight is also positively correlated with the single plant yield ($r=0.04$).

Table 1. Genetic variability estimates of nine quantitative characters of red sorghum

Character	DFF	DM	PH (cm)	NL	LL (cm)	LW (cm)	SD (cm)	TW (g)	SPY (g)
PCV(%)	9.80	6.54	20.36	7.14	11.75	7.54	14.05	23.59	44.52
GCV(%)	8.72	5.96	20.27	6.06	11.62	6.35	13.66	23.47	44.43
h^2 (%)	79.26	82.94	99.03	72.0	97.87	70.92	94.49	99.03	99.57
GA	10.07	11.78	93.54	1.14	14.65	0.78	0.55	10.22	15.57
GA/mean	0.16	0.11	0.41	0.10	0.23	0.11	0.27	0.481	0.91
GAPM(%)	16.00	11.18	41.55	10.60	23.70	11.02	27.36	48.13	91.33

DFF= Days to 50 per cent flowering; DM=Days to maturity; PH=Plant height; NL=Number of leaves; LL=Leaf length; LW=Leaf width; SD=Stem diameter; TW=Test weight; SPY=Single plant yield

Table 2. Correlation estimates of nine quantitative characters of red sorghum

Character	DFF	DM	PH	NL	LL	LW	SD	TW	SPY
DFF	1.00								
DM	0.6938	1.0000							
PH	0.1199*	0.0979	1.0000						
NL	0.0298*	0.1035	0.0643	1.0000					
LL	-0.056*	-0.0179*	-0.0196	0.0019	1.0000				
LW	0.0563*	0.0567 *	-0.0186	0.0564	-0.0374	1.0000			
SD	0.2006	0.1057	0.0613	0.0826	-0.1282	0.1776*	1.0000		
TW	-0.098*	-0.1038*	-0.1074	0.0921	0.0624	0.1627 *	-0.0527	1.0000	
SPY	0.0995*	0.0201	0.6115*	0.0104	0.0922	-0.0804	0.0302	0.435	1.0000

*Significant at 5% level

Table 3. Path estimates of nine quantitative characters of red sorghum

Character	DFF	DM	PH	NL	LL	LW	SD	TW	SPY
DFF	0.1118	-0.0746	0.0735	-0.0006	-0.0060	-0.0040	0.0022	-0.0029	0.0995
DM	0.0776	-0.1075	0.0601	-0.0022	-0.0019	-0.0040	0.0012	-0.0031	0.0201
PH	0.0134	-0.0105	0.6132	-0.0014	-0.0021	0.0013	0.0007	-0.0032	0.6115
NL	0.0033	-0.0111	0.0394	-0.0211	0.0002	-0.0040	0.0009	0.0027	0.0104
LL	-0.0063	0.0019	-0.0120	-0.0000	0.1056	0.0026	-0.0014	0.0018	0.0922
LW	0.0063	-0.0061	-0.0114	-0.0012	-0.0039	-0.0708	0.0019	0.0048	-0.0804
SD	0.0224	-0.0114	0.0376	-0.0017	-0.0135	-0.0126	0.0109	-0.0016	0.0302
TW	-0.0110	0.0112	-0.0659	-0.0019	0.0066	-0.0115	-0.0006	0.297	0.435

Residual effect: 0.6758

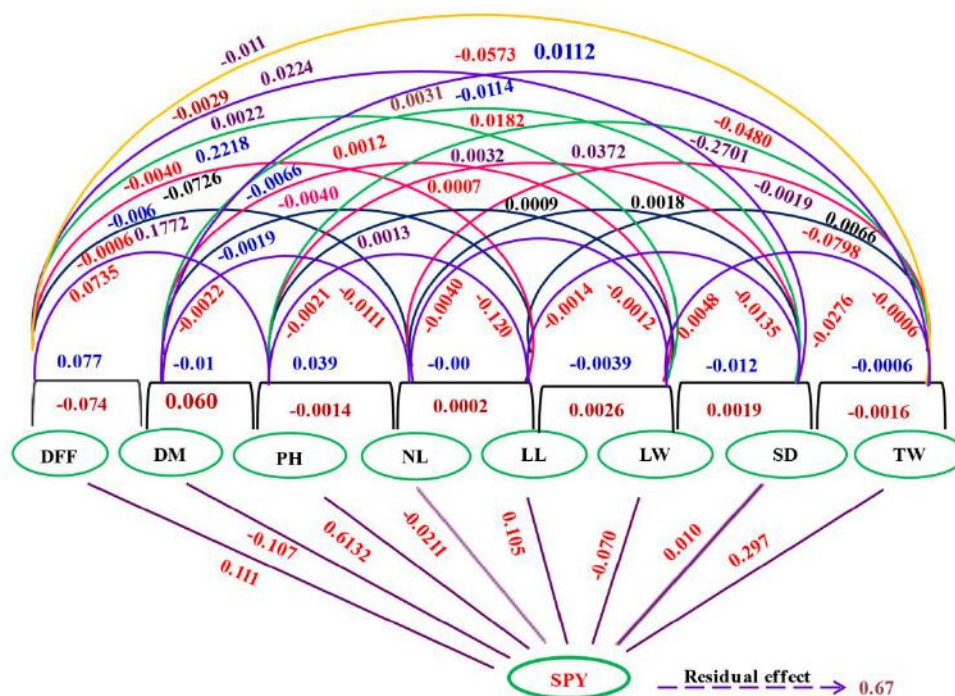


Fig. 1. Phenotypic Path coefficient

The correlation study gives the direction of selection but out of numerous correlation coefficients, it's hard to find the mutual effects between the traits (Ikanovic *et al.*, 2011). So, it is also necessary to study the path coefficient analysis (Mahajan, 2011). The trait plant height exhibits a high positive direct effect with the single plant yield (**Table 3. and Fig.1**). Similar results were exploited by Varaprasad *et al.* (2019). Test weight has shown a moderately positive effect on the single plant yield. Leaf length and days to 50 per cent flowering have shown a low positive direct effect on the single plant yield. The other remaining characters have shown a negligible effect on the single plant yield. Kavipriya *et al.* (2020) observed similar result. The selection based on plant height and test weight will be most effective to increase the single plant yield because these characters have shown a good positive significant direct effect with the single plant yield.

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