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Relationship between Yield and Yield Contributing Traits in Sorghum [*Sorghum bicolor* (L) Moench]

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Knowledge about the association between grain yield and yield contributing traits is important for sorghum development programs. Thus, the aim of this study was to determine correlations and path-coefficients between grain yield per plant and yield contributing traits. The experiment was conducted during Kharif 2019 in the Department of millets, TNAU, Coimbatore, India by using nine parents and twenty hybrids to study the genotypic correlations on the basis of seventeen traits. Analysis of variance evinced significant variation for all the traits under study. In correlation studies, the grain yield was positively associated with plant height (0.603), leaf length (0.613), leaf area index (0.501), flag leaf length (0.529), panicle length (0.608), panicle weight (0.930) and hundred seed weight (0.643). In path analysis, the traits leaf length, flag leaf length, panicle length, panicle weight and hundred seed weight exposed highly direct and indirect effects. Selection for a trait is effective when both the correlation and direct effect are higher and positive as this indicates its true association. Hence this investigation revealed flag leaf length, panicle length, panicle weight and hundred seed weight exhibited positive association and direct effect on grain yield, which indicates that the selection towards these characters will improve the yield.

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Keywords: Association; correlation; path and yield.

1. INTRODUCTION

Among the farming community sorghum is one of the good choices as a food and fodder crop [1]. Because it was renowned as the more tolerant to many stresses viz., drought, heat, flooding and salinity when compared to other major cereal crops [2] and prominently occupied in the arid and semi-arid zone of the world. It was labeled as a 'Nutritional Grain' because of its high nutritional profile [3]. As the world's population and livestock increase, poverty will become more prevalent in the future. The research claims that strengthening productivity is the key to alleviating poverty. This necessitates the development of an appropriate method for achieving high yield potential. Exploring the links between economically beneficial traits is a feasible method to boost productivity in a short span of time. The mutual interactions between each character over the other character possess an important role because traits that exhibit a defining pattern of association play an important role in the selection of varieties. Even though the association among the two traits can be phenotypic, genotypic, or environmental, but only genotype correlations are inheritable in nature [4]. By using simple correlation coefficients, the simple linear relationships among the yield and yield contributing traits are measured. The total correlation may sometimes mislead selection because of pleiotropy [5]. Correlation is simply a measure of association; does it offer conclusions about the effect and cause and it does not provide inferences about the type of relationship that regulates the character pair Y/X [6,7]. As a result, indirect selection based on correlated response may not always be successful. This necessitates a further split of the correlation coefficients into non-linear, referred to as path-coefficients [8]. In this sense, path analysis allows the partition of correlation coefficient in direct and indirect effects [9]. This is due to the fact that as the number of variables influencing a dependent variable grows, so does the interdependence among those variables. As a result, using this statistical technique, it can assess the environmental effect on character interrelationships. The goal of this study was to find genetic relationships between characteristics and perform path analysis between yield and yield contributing traits.

2. MATERIALS AND METHODS

2.1 Plant Materials, Traits Studied and Experimental Site

The present investigation was to study the correlation, path analysis for yield and yield contributing characters during Kharif 2019 in the Department of millets, TNAU, Coimbatore, India located at a latitude 11.0231N, longitude 76.9286E. The altitude of the experimental location is 426.72 m above MSL (Mean Sea Level). The soil type is clay soil. The genetic material of the present study comprises of twenty hybrids which were produced through L x T fashion by five diverse lines (CO(S) 28, CO 30, CSV 27, K 12 and SPV 2424) were crossed on to each of the four testers (IS 88, IS 18551, IS 9807 and SPV 759). In each replication at physiological maturity, the biometrical observations were recorded on five randomly selected plants and the average per plant was taken for various yield and its attributing traits viz., grain yield per plant (g), plant height (cm), stem diameter (mm), days to fifty % flowering, number of nodes/plant, number of leaves/plant, leaf length (cm), leaf breadth (cm), leaf area index, flag leaf length, flag leaf breath, flag leaf area, panicle length (cm), panicle exertion (cm), panicle weight (cm), days to maturity and hundred seed weight (g).

2.2 Statistical Analysis

The association study showed the direction of selection for better performing genotypes. The correlation for yield and yield component characters in sorghum are presented in (Table 1). Correlation analysis was performed using the Spss software. Pearson's correlation coefficients (R) were computed at a significance level of $P <$ .05 and .01. For all the traits under study the path analyses were estimated as per [10]. The direct and indirect effect for yield and yield component traits in sorghum are presented in (Table 2). The analysis was carried out by TNAU-STAT software.

3. RESULTS AND DISCUSSION

3.1 Correlation Analysis

For all of the traits, analysis of variance revealed significant (P < .01) differences among the parents and hybrids, indicating that for analyzing the association traits a wide range of variability

Table 1. Association between seventeen yield and yield contributing traits in sorghum

	PH	SD	DFF	NN	NL	LL	LB	LAI	FLL	FLB	FLA	PL	PE	PW	DM	HSW	GYP
PH	1																
SD	0.427*	1															
DFF	0.130	0.245	1														
NN	0.421*	0.207	-0.054	1													
NL	0.415*	0.575**	0.197	0.623**	1												
LL	0.409*	0.511**	0.428*	0.261	0.556**	1											
LB	-0.023	0.340	0.081	0.421*	0.436*	0.679**	1										
LAI	0.226	0.463*	0.306	0.334	0.503**	0.929**	0.892**	1									
FLL	0.397*	0.267	0.257	0.292	0.321	0.445*	0.503**	0.525**	1								
FLB	-0.193	0.314	-0.097	-0.076	0.150	0.156	0.477**	0.316	0.359	1							
FLA	0.069	0.372*	0.069	0.068	0.224	0.297	0.547**	0.449*	0.738**	0.884**	1						
PL	0.643**	0.298	0.298	0.175	0.232	0.294	0.065	0.208	0.570**	0.005	0.283	1					
PE	-0.275	-0.059	-0.079	-0.417*	-0.394*	-0.304	-0.439*	-0.361	-0.543**	-0.398*	-0.488**	-0.368*	1				
PW	0.725**	0.239	0.329	0.326	0.311	0.556**	0.147	0.424*	0.573**	-0.229	0.128	0.696**	-0.221	1			
DM	0.209	0.363	0.668**	-0.050	0.023	0.332	-0.021	0.200	0.024	-0.188	-0.068	0.158	0.211	0.324	1		
HSW	0.224	0.031	0.269	0.147	0.125	0.431*	0.174	0.372*	0.107	-0.369*	-0.208	0.128	0.154	0.628**	0.320	1	
GYP	0.603**	0.221	0.332	0.276	0.301	0.613**	0.229	0.501**	0.529**	-0.192	0.111	0.608**	-0.279	0.930**	0.228	0.643**	1

**. Correlation is significant at the 0.05 level.*
***. Correlation is significant at the 0.01 level.*

PH	:	*Plant height*	*LB*	:	*Leaf breath*	*PE*	:	*Panicle exertion*
SD	:	*Stem diameter*	*LAI*	:	*Leaf area index*	*PW*	:	*Panicle weight*
DFF	:	*Days to fifty % flowering*	*FLL*	:	*Flag leaf length*	*DM*	:	*Days to maturity*
NN	:	*Number of nodes*	*FLB*	:	*Flag leaf breath*	*HSW*	:	*Hundred seed weight*
NL	:	*Numbers of leaves*	*FLA*	:	*Flag leaf area*	*GYP*	:	*Grain yield per plant*
LL	:	*Leaf length*	*PL*	:	*Panicle length*			

Table 2. Direct and indirect effects of path analysis for fifteen yield and yield contributing traits in sorghum

	PH	**SD**	**DFF**	**NN**	**NL**	**LL**	**LB**	**FLL**	**FLB**	**PL**	**PE**	**PW**	**DM**	**HSW**	**GYP**
PH	**-0.293**	0.075	-0.001	0.119	0.044	0.150	-0.006	0.066	0.057	0.292	0.036	0.141	-0.011	0.072	0.639
SD	-0.202	**0.147**	-0.022	0.048	0.035	0.209	-0.123	0.044	-0.093	0.225	0.005	0.062	-0.022	0.024	0.337
DFF	-0.006	0.042	**-0.075**	0.032	0.016	0.234	-0.163	0.027	-0.016	0.180	0.004	0.048	-0.045	0.027	0.307
NN	-0.278	0.042	-0.014	**0.168**	0.040	0.137	-0.126	0.054	0.061	0.225	0.050	0.111	-0.017	0.071	0.523
NL	-0.249	0.074	-0.017	0.097	**0.069**	0.233	-0.117	0.056	-0.033	0.224	0.043	0.104	0.004	0.051	0.539
LL	-0.139	0.073	-0.041	0.054	0.038	**0.423**	-0.282	0.051	-0.003	0.233	0.014	0.099	-0.026	0.118	0.611
LB	-0.006	0.046	-0.031	0.054	0.021	0.305	**-0.190**	0.060	-0.055	0.141	0.023	0.036	-0.009	0.082	0.275
FLL	-0.187	0.047	-0.015	0.065	0.028	0.155	-0.169	**0.138**	-0.062	0.301	0.059	0.098	0.006	-0.010	0.455
FLB	0.090	0.055	-0.005	-0.041	0.009	0.005	-0.086	0.034	**-0.150**	-0.006	0.022	-0.059	0.013	-0.099	-0.320
PL	-0.231	0.066	-0.027	0.076	0.031	0.198	-0.110	0.084	0.003	**0.497**	0.049	0.151	-0.015	0.095	0.867
PE	0.115	-0.005	0.002	-0.070	-0.024	-0.048	0.073	-0.067	0.045	-0.198	**-0.122**	-0.055	-0.023	0.030	-0.348
PW	-0.310	0.051	-0.020	0.105	0.040	0.234	-0.078	0.076	0.082	0.421	0.038	**0.299**	-0.021	0.125	0.920
DM	-0.057	0.041	-0.043	0.038	-0.004	0.142	-0.047	-0.011	0.041	0.094	-0.037	0.049	**-0.078**	0.062	0.191
HSW	-0.134	0.017	-0.010	0.056	0.017	0.237	-0.151	-0.006	0.118	0.224	-0.017	0.106	-0.023	**0.310**	0.643
RESIDUE= **0.2183**															

PH	*:*	*Plant height*	*LB*	*:*	*Leaf breath*	*PE*	*:*	*Panicle exertion*
SD	*:*	*Stem diameter*	*LAI*	*:*	*Leaf area index*	*PW*	*:*	*Panicle weight*
DFF	*:*	*Days to fifty % flowering*	*FLL*	*:*	*Flag leaf length*	*DM*	*:*	*Days to maturity*
NN	*:*	*Number of nodes*	*FLB*	*:*	*Flag leaf breath*	*HSW*	*:*	*Hundred seed weight*
NL	*:*	*Numbers of leaves*	*FLA*	*:*	*Flag leaf area*	*GYP*	*:*	*Grain yield per plant*
LL	*:*	*Leaf length*	*PL*	*:*	*Panicle length*			

present in this study. Totre et al. [11] studied eleven traits in 14 parents, their 40 hybrids along with one standard check CSH-15R sorghum and reported all the traits are significant. The correlation coefficient estimates the extent and direction of association between the studied traits. The study's findings revealed that, the genotypic correlations are a strong intrinsic link between the traits, their manifestation is limited due to environmental influences. If the analyzed characters have insignificant genotypic values indicates the character's independence in nature. Genotypic correlation coefficients between the various traits, computed are presented in Table 1. The grain yield per plant showed a highly direct positive association (P<0.01) with plant height (0.603), leaf length (0.613), leaf area index (0.501), flag leaf length (0.529), panicle length (0.608), panicle weight (0.930) and hundred seed weight (0.643). This indicating that there is changes in any of the above traits, that changes the grain yield. These findings are in agreement with earlier reports of Thant *et al*. [8] for plant height, leaf length and panicle length. Regarding inter-correlation only for important traits with highly significant association (r= >0.6) are discussed below here. The Plant height had a positive significant correlation with panicle length (0.643) and panicle weight (0.725). The direct association exhibited between days to fifty % flowering with days to maturity (0.668), which shows that duration of days to fifty % flowering is less, the early maturity will occur and give short duration variety vice versa. Leaf/flag leaf length and breadth expressed a highly positive significant association with leaf area index/flag leaf area. This means that when there are a lot of leaves, there's a lot of surface area for photosynthesis; more photosynthesis means more photosynthates, and more yield [12]. The high positive significant genotypic correlation coefficient was observed between panicle length with panicle weight (0.697). The Panicle weight had a strong association with a hundred seed weight (0.628). Thus, the correlation coefficient study indicated that the plant height, leaf length, leaf area index flag leaf length panicle length panicle weight and hundred seed weight are important characters in deciding the grain yield per plant. Hence these traits could be used as selection indices in a sorghum breeding program. This finding is in agreement with [13,14, 15 & 8].

3.2 Path Analysis

The simple correlation coefficient is merely a measure of the degree of relationship between two traits; it does not reveal the cause of that link. But path analysis is the ultimate source for determining the causes, measurements, and relative contributions of causal factors when studying the causal basis of association. The direct and indirect effects of characteristics on yield are measured using path analysis. In path analysis, only fifteen traits are used except leaf area index and flag leaf area. When yield and yield components were partitioned into direct and indirect impacts (Table 2), it was revealed that direct effect exhibited in panicle length (0.497), leaf length (0.423) and hundred seed weight (0.310) panicle weight (0.299) expressed highly positive direct effect. Kavya *et al.* [13] reported that panicle weight showed highly direct effect. Nirosh et al. [14] evaluated 250 F_2 and reported leaf length had positive direct effect. Among the indirect effects of various traits on grain yield per plant the panicle weight exposed a high indirect effect on grain yield per plant via panicle length (0.421). If panicle length increases the number of grains per panicle and the number of primary branches also increase, which indirectly increase panicle weight. Leaf breath had a positive high indirect effect with leaf length (0.305). Increases in leaf length and breadth directly increase leaf surface, if LAI is increase the photosynthesis efficiency meanwhile it increasing the grain yield per plant [12]. Flag leaf length exposed indirect effect on grain yield via panicle length (0.301). During grain filling stage in cereals the flag leaf contributes 41 to 43% to grain weight [16]. Removal of flag leaf results in a significant reduction of grain yield [17]. The residual value is about 0.2183. The low residual value indicates that there is sufficient numbers of yield contributing traits are recorded. This result was consonance with Ravali et al. [15]. The above result exhibited that the traits viz., leaf length, flag leaf length, panicle length, panicle weight and hundred seed weight will directly or indirectly affect the grain yield per plant, this are all the important traits while selection and breeding programmes. The differences in the study material, techniques, and environmental conditions could explain some of the minor inconsistencies between these past studies and the current one.

4. CONCLUSION

This investigation suggested that most of the traits evaluated were positively associated. Among them flag leaf length, panicle length, panicle weight and hundred seed weight have significant positive correlation and direct effect on grain yield. Therefore, while planning a breeding programme for increased yield per plant, due consideration should be given to these traits.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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