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Studies on character association and path analysis for grain yield and yield attributes in *rabi* sorghum [*Sorghum bicolor* L. Moench]

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Abstract
In order to investigate the association between various quantitative traits and grain yield per plant, forty sorghum hybrids were assessed including both parents and four checks, *viz*., CSV 29R, M35-1, SPV 2217 and CSH 13R. The correlation study exhibited positive association of grain yield per plant with panicle weight (0.986), number of seeds per panicle (0.852), panicle width (0.569), hundred seed weight (0.544), number of primaries per panicle (0.282), days to maturity (0.281) and days to 50 percent flowering (0.229). Further, path analysis showed that number of seeds per panicle (0.095), panicle weight (0.081), panicle length (0.052), hundred seed weight (0.017), plant height (0.012) and days to maturity (0.007) exerted high direct effects on grain yield per plant and it also showed lower residual effect which indicated the appropriate selection of characters for the study. From this study, it is observed that panicle weight and number of seeds per panicle made the most contribution to grain yield per plant. As a result, it is suggested to employ these traits as selection criteria for grain yield improvement in *rabi* sorghum.

Keywords: Path analysis, correlation, grain yield per plant, selection, sorghum

Introduction
Globally sorghum (*Sorghum bicolor* L. Moench) is one of the most important cereal crops cultivated in semi-arid tropics. It is typically cultivated as food-fodder crop at subsistence levels by the farmers with minimal resources and inputs. Sorghum is emerging as a possible alternative feed and bioenergy crop as a result of the recent rapid expansion of the poultry industry and the enormous need for fuel-grade ethanol. As a result, sorghum is evolving as a '4F' crop—food, fodder, feed and fuel. In addition, its resilience to high temperatures and drought makes it a climate ready crop. Therefore, sorghum has comparative advantages over other summer cereals, including the ability to fill grain during a drought towards the final stage of the crop. Due to its widespread use, there is need for improvement with regard to a number of traits. In achieving this goal, special attention is given to grain yield as the most important trait. But grain yield being a quantitative trait controlled by polygenes, it depends upon several other component traits. Therefore, it is crucial to understand how grain yield and its contributing traits are interrelated. To determine such association, correlation analysis is used. The better understanding about yield components will help the plant breeder during selection. When two desirable trait had a positive genetic correlation, the plant breeder's job is made easier because improvement in one character will also improves the other trait. However, if two desirable traits are negative correlated, the simultaneous improvement in both traits would be hampered. The simple correlation of these traits with grain yield does not provide a clear understanding of the biological basis of their relationships, which makes the correlation unreliable (Khairwal *et al.*, 1999) [4]. Therefore, path coefficient analysis originally proposed by Wright (1921) and described by Dewey and Lu (1959) [2] provides the ability to partition correlation coefficients into direct and indirect effects of several traits on dependent variable and determining cause and effect relationship, resulting in effective selection. Hence, the present study was undertaken to elucidate the information on character association and direct and indirect effect of yield components on grain yield by utilizing correlation coefficient and path analysis.

Material and Methods
The experimental material for the present study comprised of ten restorers which were crossed with four male sterile lines in line × tester mating design to generate forty hybrids during

kharif 2021. These hybrids were assessed for yield and yield attributing traits in randomized complete block design with three replications along with fourteen parental lines and four checks *viz.*, CSV 29R, M35-1, SPV 2217 and CSH 13R at MARS, Dharwad during *rabi* 2021-22. Each entry was raised in two rows with a row length of 3m and the spacing maintained was 45cm between rows and 20cm between plants. The ideal package of practices was followed to raise a healthy crop. The observation was recorded on five competitive plants within each entry for eleven traits *viz.*, days to 50 percent flowering, plant height (cm), number of leaves, days to maturity, panicle length (cm), panicle width (cm), panicle weight (g), number of primaries per panicle, number of seeds per panicle, hundred seed weight (g) and grain yield per panicle (g). The mean values of all the observation were used for statistical analysis. The correlation coefficient and path analysis was carried out by using R studio.

Results and Discussion

The results of analysis of variance indicated that all the genotypes differed significantly suggesting a sufficient variability in all the characters Table 1.

The association between the characters were effectively measured by correlation studies. Correlation coefficient helps in selecting the number of traits for improving the grain yield. Therefore, identifying the traits associated with yield and their relationships among one another is crucial information for plant breeders. The values regarding phenotypic and genotypic correlation coefficients for 11 characters are presented in Table 2 and 3. In the current investigation, the phenotypic correlation coefficients for most of the characters were lower in magnitude than their corresponding genotypic correlation coefficients indicating the strong inherent relationship among the characters.

Grain yield per plant was found positively and significantly correlated with panicle weight, number of seeds per panicle, panicle width, hundred seed weight, number of primaries per panicle, days to maturity and days to 50 percent flowering at both phenotypic and genotypic level. And none of the character had significant negative association with grain yield. Results indicated that genotypes with larger and wider panicles, more primaries per panicle, seeds per panicle, and hundred seed weights produced a higher yield. Therefore, these traits are crucial for increasing sorghum grain yield. These results are in agreement with Patel *et al.* (1980) [6] and Rizwan Haris (2001) [8] and Warkad *et al.* (2010) [9].

The correlation coefficients analysis may give deceiving outcomes due to influence of third factor on the association between two variables. In order to understand the nature of the relationship between dependent and independent variables, it is necessary to examine the cause-and-effect relationship between them. Path coefficient analysis (Dewey and Lu 1957) [2] provided a means of separating the correlation coefficient into direct and indirect effect and offers information on real influence of a trait on the yield.

In the present experiment, the direct and indirect effects of ten characters on grain yield per plant were measured using path analysis (Table 4 and 5). It can be seen from the table 4 that number of seeds per panicle, panicle weight, panicle length, hundred seed weight, plant height and days to maturity recorded positive direct effect on grain yield per plant at phenotypic level. These findings concur with those of Iyanar et al. (2001) [3], Warkad et al. (2010) [9], and Mahajan et al. (2011) [5] for panicle length. As a result, panicle length directly influences grain yield, suggesting that selection for this trait can be done to for grain yield improvement. Selection towards other characters like panicle weight, number of seeds per panicle and hundred grain weight will also increase grain yield. Consequently, the characters *viz.*, days to 50 percent flowering, number of leaves, panicle width and primaries per panicle had a negative direct effect on grain yield. Similar results were reported by Vijaya Kumar *et al.* (2012) [8] and Arun Kumar (2013) [1] for days to 50 percent flowering. These results indicated that genotypes with too early and too late flowering may reduce the yield levels in sorghum. Therefore, the breeder must choose the ideal flowering period that corresponds to sorghum grain yield. Number of leaves had indirect effect on grain yield with significant positive correlation through some other traits *viz.*, panicle weight, number of seeds per panicle, panicle length, hundred seed weight, plant height, days to maturity and panicle width. Similarly, panicle width recorded positive indirect effect on grain yield through days to 50 percent flowering and number of leaves. The number of primaries per panicle had negative indirect effect on grain yield through all the characters studied. In the light of results obtained in the present study, it is possible to draw the conclusion that selection of component traits such as number of seeds per panicle, panicle weight, panicle length, hundred seed weight, plant height and days to maturity could lead to improvement in grain yield per plant. The residual effect for all the characters studied was 0.0248. The less residual effect indicated the adequacy of the trait chosen for path analysis.

Table 1: Analysis of variance for different quantitative characters of sorghum

Source of variation	df	Days to 50% flowering	Plant height (cm)	Number of leaves	Days to maturity	Panicle length (cm)	Panicle width (cm)	Panicle weight (g)	Number of primaries per panicle	Number of seeds per panicle	Hundred seed weight (g)	Grain yield per panicle (g)
Replications	2	12.86	1380.25	5.21	5.49	5.63	1.09	274.73	144.75	349178.77	0.35	83.19
Parents	13	291.11**	5054.64**	17.07**	460.18**	63.71**	0.62*	562.02**	1328.69**	478907.89**	0.59**	426.34**
Lines	9	401.76**	2739.55**	20.79**	668.95**	72.76**	0.42	494.79**	2635.73**	434982.92**	0.59**	373.03**
Testers	3	27.19**	8442.79**	7.93**	312.62**	39.33**	1.11*	922.51**	450.07**	673973.89**	0.76**	717.65**
Lines vs Testers	27	86.86**	15725.95**	11.07**	681.49**	55.46**	0.39	85.67	1.19	289028.36	0.38	32.27
Parent vs Crosses	1	1487.85**	5146.28**	41.94**	1668.74**	105.83**	9.44**	4416.09**	232.86*	300463.41	1.34**	2347.92**
Crosses	39	176.66**	995.89**	8.14**	215.81**	29.02**	0.94*	2060.23**	436.77**	1041020.99**	0.89**	1431.66**
Error	106	8.93	350.26	1.49	7.14	2.06	0.31	107.72	53.73	78394.97	0.13	82.97

*, ** - Significant at 5 % and 1 % level of probability, respectively

Table 2: Phenotypic correlation coefficient among yield and yield related traits.

Characters	Days to 50 percent flowering	Plant height (cm)	Number of leaves	Days to maturity	Panicle length (cm)	Panicle width (cm)	Panicle weight (g)	Number of primaries per panicle	Number of seeds per panicle	Hundred seed weight (g)	Grain yield per panicle (g)
Days to 50% flowering	1	0.428**	0.746**	0.785**	-0.391**	-0.045	0.235**	0.415**	0.258**	0.388**	0.229**
Plant height (cm)		1	0.496**	0.422**	-0.135	0.043	0.124	0.295**	0.065	0.285**	0.121
Number of leaves			1	0.636**	-0.263**	-0.108	0.146	0.354**	0.171*	0.276**	0.141
Days to maturity				1	-0.243**	0.101	0.289**	0.363**	0.276**	0.318**	0.281**
Panicle length (cm)					1	0.313**	0.173*	-0.476**	0.199**	-0.232**	0.147
Panicle width (cm)						1	0.592**	0.073	0.525**	0.260**	0.569**
Panicle weight (g)							1	0.293**	0.845**	0.537**	0.986**
Number of primaries per panicle								1	0.284**	0.338**	0.282 **
Number of seeds per panicle									1	0.433**	0.852**
Hundred seed weight (g)										1	0.544**
Grain yield per panicle (g)											1

*, ** - Significant at 5 % and 1 % level of probability, respectively

Table 3: Genotypic correlation coefficient among yield and yield related traits.

Characters	Days to 50 percent flowering	Plant height (cm)	Number of leaves	Days to maturity	Panicle length (cm)	Panicle width (cm)	Panicle weight (g)	Number of primaries per panicle	Number of seeds per panicle	Hundred seed weight (g)	Grain yield per panicle (g)
Days to 50% flowering	1	0.574**	0.932**	0.846**	-0.465**	-0.093	0.289*	0.502**	0.311*	0.522**	0.295 *
Plant height (cm)		1	0.733**	0.549**	-0.187	0.099	0.164	0.354**	0.024	0.409**	0.139
Number of leaves			1	0.780**	-0.388**	-0.131	0.158	0.458**	0.197	0.379**	0.152
Days to maturity				1	-0.272*	0.134	0.321	0.393**	0.316*	0.423**	0.321*
Panicle length (cm)					1	0.405**	0.185	-0.571**	0.174	-0.317*	0.158
Panicle width (cm)						1	0.885**	0.029	0.806**	0.464**	0.877**
Panicle weight (g)							1	0.323*	0.987**	0.654**	0.999**
Number of primaries per panicle								1	0.331*	0.428**	0.314*
Number of seeds per panicle									1	0.510**	0.994**
Hundred seed weight (g)										1	0.661**
Grain yield per panicle (g)											1

*, ** - Significant at 5 % and 1 % level of probability, respectively

Table 4: Phenotypic path coefficient among yield and yield related traits.

Characters	Days to 50 percent flowering	Plant height (cm)	Number of leaves	Days to maturity	Panicle length (cm)	Panicle width (cm)	Panicle weight (g)	Number of primaries per panicle	Number of seeds per panicle	Hundred seed weight (g)	Correlation coefficient of yield attributing traits with grain yield per panicle(g)
Days to 50% flowering	-0.0379	0.0052	-0.0013	0.0061	0.0204	0.0010	0.2201	-0.0115	0.0246	0.0064	0.229**
Plant height (cm)	-0.0163	0.0122	-0.0009	0.0033	0.0071	-0.0009	0.1163	-0.0111	0.0062	0.0047	0.121
Number of leaves	-0.0283	0.0061	-0.0018	0.0049	0.0138	0.0025	0.1361	-0.0133	0.0163	0.0046	0.141
Days to maturity	-0.0298	0.0052	-0.0011	0.0078	0.0127	-0.0023	0.2707	-0.0137	0.0264	0.0053	0.281**
Panicle length (cm)	0.0148	0.0017	0.0005	-0.0019	0.0524	-0.0072	0.1618	-0.0179	0.0191	-0.0039	0.147
Panicle width (cm)	0.0017	0.0005	0.0002	0.0008	0.0164	-0.0229	0.5534	-0.0028	0.0501	0.0043	0.569**
Panicle weight (g)	-0.0089	0.0015	-.0003	0.0023	0.0091	-0.0135	0.9349	-0.0110	0.0807	0.0089	0.986**
Number of primaries per panicle	-0.0157	0.0036	-0.0006	0.0028	0.0249	-0.0017	0.2735	-0.0377	0.0271	0.0056	0.282 **
Number of seeds per panicle	-0.0097	0.0008	-0.0003	0.0022	0.0105	-0.0120	0.7899	-0.0107	0.0955	0.0072	0.852**
Hundred seed weight (g)	-0.0147	0.0035	-0.0005	0.0025	0.0122	-0.0059	0.5018	-0.0127	0.0413	0.0167	0.544**

Table 5: Genotypic path coefficient among yield and yield related traits.

Characters	Days to 50 percent flowering	Plant height (cm)	Number of leaves	Days to maturity	Panicle length (cm)	Panicle width (cm)	Panicle weight (g)	Number of primaries per panicle	Number of seeds per panicle	Hundred seed weight (g)	Correlation coefficient of yield attributing traits with grain yield per panicle(g)
Days to 50% flowering	0.2031	-0.0447	-0.0222	-0.0691	0.0225	-0.0149	0.2928	-0.0069	-0.0394	-0.0263	0.295 *
Plant height (cm)	0.1165	-0.0779	-0.0175	-0.0481	0.0090	0.0161	0.1662	-0.0049	-0.0030	-0.0206	0.139
Number of leaves	0.1893	-0.0571	-0.0238	-0.0637	0.0188	-0.0210	0.1601	-0.0063	-0.0250	-0.0191	0.152
Days to maturity	0.1717	-0.0427	-0.0186	-0.0817	0.0132	0.0216	0.3251	-0.0054	-0.0401	-0.0213	0.321*
Panicle length (cm)	-0.0943	0.0145	0.0093	0.0220	-0.0485	0.0651	0.1876	0.0078	-0.0221	0.0159	0.158
Panicle width (cm)	-0.0189	0.0078	0.0031	-0.0109	-0.0196	0.1609	0.8960	-0.0004	-0.1023	-0.0234	0.877**
Panicle weight (g)	0.0587	-0.0128	-0.0038	-0.0262	-0.0090	0.1424	1.0123	-0.0044	-0.1253	-0.0329	0.999**
Number of primaries per panicle	0.1019	-0.0276	-0.0109	-0.0321	0.0277	0.0047	0.3274	-0.0137	-0.0420	-0.0216	0.314*
Number of seeds per panicle	0.0631	-0.0019	-0.0047	-0.0258	-0.0084	0.1296	0.9994	-0.0045	-0.1269	-0.0257	0.994**
Hundred seed weight (g)	0.1059	-0.0318	-0.0090	-0.0345	0.0154	0.0746	0.6616	-0.0059	-0.0648	-0.0504	0.661**

Conclusion

Studies on correlation revealed that grain yield exhibited positive association with panicle weight, number of seeds per panicle, panicle width, hundred seed weight, number of primaries per panicle, days to maturity and days to 50 percent flowering. Therefore, in order to increase grain yield, selection based on these traits would be favorable. According to path analysis, number of seeds per panicle, panicle weight, panicle length, hundred seed weight, plant height and days to maturity had significant direct impact on grain yield. The traits *viz.*, panicle weight, number of seeds per panicle, hundred seed weight and days to maturity had positive correlation coefficient and substantial direct effects for grain yield. Therefore, it is suggested to consider these traits as principal yield contributing components and to use these as selection criteria for grain yield improvement in sorghum. It was also concluded that indirect selection *via* traits with significant direct effects on grain yield ultimately increases the yield levels in sorghum.

References

1. Arun Kumar B. Genetic variability, character association and path analysis studies in sorghum (*Sorghum bicolor* L. Moench). The Bioscan. 2013;8(4):1485-1488.
2. Dewey DR, Lu KHA. correlation and path coefficient analysis of components of crested wheatgrass seed production. Agron. J. 1959;51:515-518.
3. Iyanar K, Gopalan A, Ramasamy P. Correlation and path analysis in sorghum. Ann. Agric. Res. 2001;22(4):495-497.
4. Khairwal IS, Rai KN, Andrew DJ, Harinarayana G. Pearl millet breeding. Oxford and IBH Publishing Co., New Delhi; c1999. p. 480-506.
5. Mahajan RC, Wadikar PB, Pole SP, Dhuppe MV. Variability, Correlation and Path Analysis Studies in Sorghum. Research Journal of Agricultural Sciences. 2011;2(1):101-103.
6. Patel RH, Desai KB, Raj KRV, Parikh RK. Estimates of heritability and genetic advance and other genetic parameters in an F2 populations of sorghum. Sorghum Newslett; c1980. p. 22-23.
7. Rizwan HM. Estimation of genetic diversity in germplasm collections of rabi sorghum (Sorghum bicolor L. Moench). M.Sc. (Agri.) Thesis, Univ. Agric. Sci., Dharwad, Karnataka; c2001. p. 26-80.
8. Vijaya Kumar N, Reddy CVC, Reddy PVRM. Path analysis among rabi sorghum genotypes (*Sorghum bicolor* (L) moench). Plant Archives. 2012;12(2):959-960.
9. Warkad YN, Tidke RT, Maske NM, Kharde AV, Potdukhe NR. Character association and path analysis in sorghum (*Sorghum bicolor* L. Moench). Inter. J. of Agric. Sci. 2010;1(6):100-104.
10. Wright S. Systems of mating. Genetics. 1921;6:111-178.