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## Studies on correlation and path coefficient analysis in rabi sorghum germplasm (*Sorghum bicolor* L. Moench)

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#### Abstract

The characters correlation and their direct and indirect effects were studied in 47 germplasm lines. The association study revealed the positive and significant correlation with days to 50 per cent flowering ( $G=0.152^*$ ,  $P=0.123^*$ ), Plant height ( $G=0.231^*$ ,  $P=0.227^*$ ), Number of primaries per panicle ( $G=0.349^{**}$ ,  $P=0.343^{**}$ ), Number of grains per primary ( $G=0.303^{**}$ ,  $P=0.297^{**}$ ), panicle width ( $G=0.459^{**}$ ,  $P=0.427^{**}$ ), and Seedling vigour ( $G=0.132^*$ ,  $P=0.102^*$ ) with grain yield per plant. The partition of yield and yield attributes into direct and indirect effects revealed that the characters viz., number of grains per primary ( $G=0.273$ ,  $P=0.182$ ), panicle length ( $G=0.131$ ,  $P=0.059$ ), panicle width ( $G=0.624$ ,  $P=0.437$ ), 100 grain weight ( $G=0.116$ ,  $P=0.103$ ), physiological maturity ( $G=0.051$ ,  $P=0.007$ ), SPAD value ( $G=0.075$ ,  $P=0.041$ ), and seedling vigour ( $G=0.147$ ,  $P=0.091$ ), showed a positive direct effect on grain yield per plant. On grain yield indicating the importance of these characters hence, these characters should be considered while planning a breeding strategy by utilizing *rabi* sorghum.

**Keywords:** Rabi sorghum, correlation, path analysis, germplasm

#### Introduction

Sorghum (*Sorghum bicolor* L. Moench) is one of the major cereal crops of the Semi-Arid tropics. It is the fourth most important cereal crop following rice, wheat and maize and staple food in the semi-arid parts of the world. India is the major sorghum growing country in the world, ranks first in acreage with 6684.4 ha and second in production with 913 kg/ha next to United States of America. Major producers of sorghum in the world are USA, India, Nigeria, China, Mexico, Sudan and Argentina. Sorghum has been classified under family Graminae, subfamily Poaceae, tribe Andropogonae, genus Sorghum, Species *sorghum bicolor*. Yield is a complex character, which depends upon many independent contributing characters. Knowledge of the magnitude and type of association between yield and its components themselves greatly help in evaluating the contribution of different components towards yield. Yield being a polygenic character is highly influenced by the fluctuations in environment. Hence, selection of plants based directly on yield would not be very reliable. Improvement in sorghum yield depends on the nature and extent of genetic variability, heritability and genetic advance in the base population. Besides, the information on the nature of association between yield and its components helps in simultaneous selection for many characters associated with yield improvements (Mahajan *et al.*, 2011) [8]. The estimates of correlations alone may be often misleading due to mutual cancellation of component traits. So, it becomes necessary to study path coefficient analysis, which takes into account the casual relationship in addition to degree of relationship. The path coefficient analysis initially suggested by Wright (1921) [12] and described by Dewey and Lu (1959) [4] allows partitioning of correlation coefficient into direct and indirect contributions (effects) of various traits towards dependent variable and thus helps in assessing the cause-effect relationship as well as effective selection. Hence, this study was aimed to analyse and determine the traits having greater interrelationship with grain yield utilizing the correlation and path analysis.

#### Materials and Methods

The present field experiment on sorghum (*Sorghum bicolor* L. Moench) was conducted at Sorghum Research Station VNMKV, Parbhani during *rabi* 2022-23. Total 47 genotypes in two rows were sown (table 1). The germplasm lines were evaluated in a field experiment under Randomized Block Design (RBD) with two replications following the recommended spacing of 45cm between rows and 15cm between plants was adapted. All the recommended practices were followed to raise good crop of *rabi* sorghum.

All other crop cultural management practices were followed to raise successful crop. Five plants at arbitrarily in each plot and replication were chosen and labelled for recording observed and the mean of five plants was used for statistical analysis. The observations recorded on five randomly selected plants from each plot per replication. The replication wise mean values of the genotypes were subjected to statistical analysis. Observations were recorded on the following characters *viz.*, Days to 50% Flowering, Plant height, Number of Primaries per Panicle, Number of grains per Primary branches, Panicle length, Panicle Width, 100 seed weight, Physiological maturity, Fodder yield per plant, SPAD value, Leaf Area, Seedling Vigour, Glossiness, Relative water content, Grain yield per plant. The correlation coefficients were calculated to determine the degree of association of the yield attributes with yield and also among yield attributes themselves. The analysis of covariance was conducted by the method designed by Johnson *et al.* (1955) [7]. Path coefficient is a standardized partial regression coefficient and as such it is a measure of direct and indirect effect of set variables as a dependent variable such as grain yield. This is done as suggested by Wright (1921) [12] and elaborated by Dewey and Lu (1959) [4]. Knowledge of the relationship among yield components is essential for the formulation of breeding programmes 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.

## Results and Discussion

### Correlation coefficient analysis

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 the present investigation the estimates of genotypic correlation was higher than those of phenotypic correlation for most of the traits. These higher genotypic values whenever observed were contributed to the relative stability of the genotypes. Thus trait with higher genetic correlation may throw light on validity of selection for those traits. Correlation studies revealed that table 2 and 3. the characters *viz.*, days to 50 per cent flowering ( $G=0.152^*$ ,  $P=0.123^*$ ), Plant height ( $G=0.231^*$ ,  $P=0.227^*$ ), Number of primaries per panicle ( $G=0.349^{**}$ ,  $P=0.343^{**}$ ), Number of grains per primary ( $G=0.303^{**}$ ,  $P=0.297^{**}$ ), panicle width ( $G=0.459^{**}$ ,  $P=0.427^{**}$ ), and Seedling vigour ( $G=0.132^*$ ,  $P=0.102^*$ ) with grain yield per plant at both genotypic and phenotypic level, respectively. These results are in agreement with the earlier findings of Nimbalkar *et al.* (1988) [9], Iyanar *et al.* (2001) [5], Awari *et al.* (2003) [2], Umakant *et al.* (2004) [10], Jimmy (2017) [6], Lokesh Kumar Verma and BD Biradar (2021) [11].

**Table 1:** List of 47 sorghum germplasm line use in the experiment

Sr. No.	Germplasm line	Sr. No.	Germplasm line
1	144	25	AGR-5
2	149	26	AGR-7
3	1189-HB	27	AGR-8
4	440	28	AGR-10
5	177	29	Dark Check-ch-2
6	107	30	Dwarf Check-ch-3
7	159	31	PRDS-3(MT Red)
8	YPT-1007	32	Yellow Self Tall
9	108-Red	33	Chalky white (154)
10	143	34	IS 9108 Dwarf Red
11	162	35	Phule Revati
12	178	36	Phule Rohini
13	29416	37	Phule Suchitra
14	ISSVT-710	38	Phule Yashodha
15	Yellow Tall	39	M-35-1
16	PRDS-3	40	Phule Yashomati
17	Unkown-SPS	41	Phule Godhan
18	YPT-1021	42	Phule Anuradha
19	A-13(8) Unkown	43	Phule Vasudha
20	PRDS-3 tall		Checks
21	AGR-1	44	Parbhani Moti
22	AGR-2	45	Parbhani Supermoti
23	AGR-3	46	Parbhani Shakti
24	1008-Dark Red	47	CSV-22R

### Path coefficient analysis

Path coefficient analysis Table 4 and 5. Revealed that Number of grains per primary ( $G=0.273$ ,  $P=0.182$ ) and seedling vigour ( $G=0.147$ ,  $P=0.091$ ) exhibited positive direct effect coupled with positive significant correlation with grain yield per plant. Positive indirect effects were manifested through panicle length, panicle width, 100 seed weight, fodder yield per plant and seedling vigour. Though, panicle length ( $G=0.131$ ,  $P=0.059$ ), 100 grain weight ( $G=0.116$ ,  $P=0.103$ ), physiological maturity ( $G=0.051$ ,  $P=0.007$ ), and SPAD value ( $G=0.075$ ,  $P=0.041$ ) exhibited positive direct effects on grain yield, they did not show significant association with grain yield. Panicle width ( $G=0.624$ ,  $P=0.437$ ) exhibited positive direct effect as well as positive significant correlation with grain yield per plant. Fodder yield per plant, glossiness and relative water content showed negative direct effect along with negative significant correlation with grain yield per plant. The negative indirect effects were manifested through all other traits included in the study. Similar results were reported by, Bohra *et al.* (1986) [3], Iyanar *et al.* (2001) [5], Zinzala *et al.* (2018) [13], Lokesh Kumar Verma and BD Biradar (2021) [11], Aml *et al.* (2012) [1]. The results of path analysis indicated that panicle width and number of grains per primary showed highest positive direct effects along with positive significant correlation with grain yield in the present material under study. Thus, the present study indicated that the panicle weight, number of grains per primary and seedling vigour are important characters in deciding the grain yield per plant in the present material under study. Hence these characters may be considered as suitable selection indices in sorghum breeding programmes in the present investigation. The genotypic residual effect was 0.787 whereas. Phenotypic residual effect was 0.832. Moderate residual effect was observed in present study, it shows that there is some other factors that contribute to yield besides the character studied.

**Table 2:** Genotypic correlation coefficient for sixteen characters of *rabi* sorghum

Character	Days to 50% Flowering	Plant height (cm)	No of Primaries per Panicle	No. of grains / Primary branches	Panicle type	Panicle length (cm)	Panicle Width (cm)	100 seed weight (g)	Physiological maturity	Fodder yield/plant (g)	SPAD value	Leaf Area (cm <sup>2</sup> )	Seedling Vigour	Glossiness	Relative water content (%)	Grain yield/plant (g)
Days to 50% Flowering	1.000	-0.066	0.252*	0.090	0.367**	0.165*	0.521**	-0.085	-0.337**	-0.077	0.229*	-0.114*	-0.175*	0.004	0.037	0.152*
Plant height		1.000	0.350**	0.323**	0.032	0.174**	0.191*	0.003	-0.033	0.057	0.015	0.133*	0.182*	-0.154*	0.180*	0.231*
No of Primaries per Panicle			1.000	0.757**	0.151*	0.289**	0.406**	0.071	-0.191*	0.144	0.159*	0.035	0.203*	0.150*	-0.006	0.349**
No. of grains / Primary branches				1.000	0.157*	0.020	0.161*	0.198*	-0.075	-0.073	-0.096	-0.038	0.347**	0.195*	0.023	0.303**
Panicle type					1.000	-0.326*	0.325**	0.212*	-0.140	0.098	0.002	-0.114*	0.101*	0.035	-0.144*	0.042
Panicle length						1.000	-0.006	-0.070	-0.055	0.151*	0.151*	0.258*	-0.146*	-0.122*	0.150*	0.099
Panicle Width							1.000	-0.191*	-0.241*	0.006	0.141*	0.127*	-0.103*	0.172*	-0.234*	0.459**
100 seed weight								1.000	-0.266*	0.063	-0.014	-0.087	0.232*	-0.196*	0.136*	0.068
Physiological maturity									1.000	-0.214*	-0.264*	0.061	0.048	0.033	-0.018	-0.079
Fodder yield/plant (g)										1.000	0.194*	0.132*	-0.117*	-0.155*	-0.121*	-0.088
SPAD value											1.000	0.248*	-0.004	-0.048	-0.114*	0.090
Leaf Area												1.000	-0.078	-0.043	0.199*	0.075
Seedling Vigour													1.000	0.182*	0.233*	0.132*
Glossiness														1.000	-0.348**	-0.055
Relative water content															1.000	-0.057
Grain yield/plant (g)																1.000

\*, \*\* denotes significance at 5% and 1% respectively

**Table 3:** Phenotypic correlation coefficient for sixteen characters of *rabi* sorghum

Character	Days to 50% Flowering	Plant height (cm)	No of Primaries per Panicle	No. of grains / Primary branches	Panicle type	Panicle length (cm)	Panicle Width (cm)	100 seed weight (g)	Physiological maturity	Fodder yield/plant (g)	SPAD value	Leaf Area (cm <sup>2</sup> )	Seedling Vigour	Glossiness	Relative water Content (%)	Grain yield/plant (g)
Days to 50% Flowering	1.000	-0.049	0.212*	0.0635	0.231*	0.105*	0.377**	-0.080	-0.282**	-0.070	0.156*	-0.111*	-0.142*	0.003	0.010	0.123*
Plant height		1.000	0.345**	0.308**	0.018	0.169*	0.183	0.003	-0.029	0.058	0.011	0.121*	0.140*	-0.127*	0.174*	0.227*
No of Primaries per Panicle			1.000	0.733**	0.119*	0.287**	0.388**	0.068	-0.171*	0.143	0.151*	0.032	0.165*	0.137*	-0.009	0.343**
No. of grains / Primary branches				1.000	0.130*	0.011	0.157	0.191*	-0.052	-0.067	-0.085	-0.037	0.304**	0.177*	0.018	0.297**
Panicle type					1.000	-0.287**	0.270*	0.194*	-0.129*	0.076	0.015	-0.106	0.147*	-0.079	-0.111*	0.044
Panicle length						1.000	0.011	-0.063	0.018	0.147	0.146*	0.251*	-0.164*	-0.076	0.147*	0.092
Panicle Width							1.000	-0.179*	0.231*	0.004	0.109	0.109	-0.052	0.144*	-0.235*	0.427**
100 seed weight								1.000	-0.239*	0.060	-0.018	-0.082	0.202*	-0.175*	0.137*	0.062
Physiological maturity									1.000	0.207*	-0.220*	0.067	0.059	0.051	-0.001	-0.090
Fodder yield/plant (g)										1.000	0.195*	0.129*	-0.103*	-0.135*	-0.116	-0.091
SPAD value											1.000	0.231*	-0.006	-0.048	-0.119*	0.089
Leaf Area												1.000	-0.084	-0.030	0.203*	0.073
Seedling Vigour													1.000	0.147*	0.193*	0.102*
Glossiness														1.000	-0.295**	-0.044
Relative water content															1.000	-0.057
Grain yield/plant (g)																1.000

\*, \*\* denotes significance at 5% and 1% respectively

**Table 4:** Direct and indirect effect (Genotypic level) of sixteen characters of *rabi* sorghum germplasm

character	Days to 50% Flowering	Plant height	No of Primaries per Panicle	No. of grains per Primary branches	Panicle type	Panicle length	Panicle Width	100 seed weight	Physiological maturity	Fodder yield per plant	SPAD value	Leaf Area	Seedling Vigour	Glossiness	Relative water content	Grain Yield per Plant
Days to 50% Flowering	-0.124	0.001	-0.021	0.025	-0.048	0.022	0.325	-0.010	-0.017	0.009	0.017	0.004	-0.026	-0.001	-0.003	0.152*
Plant height	0.008	-0.012	-0.029	0.088	-0.004	0.023	0.119	0.000	-0.002	-0.006	0.001	-0.004	0.027	0.036	-0.014	0.231*
No of Primaries per Panicle	-0.031	-0.004	-0.082	0.207	-0.020	0.038	0.253	0.008	-0.010	-0.016	0.012	-0.001	0.030	-0.035	0.001	0.349**
No. of grains per Primary branches	-0.011	-0.004	-0.062	0.273	-0.020	0.003	0.100	0.023	-0.004	0.008	-0.007	0.001	0.051	-0.045	-0.002	0.303**
Panicle type	-0.046	0.000	-0.012	0.043	-0.130	-0.043	0.202	0.025	-0.007	-0.011	0.000	0.004	0.015	-0.008	0.011	0.042
Panicle length	-0.021	-0.002	-0.024	0.006	0.043	0.131	-0.004	-0.008	-0.003	-0.017	0.011	-0.008	-0.021	0.028	-0.012	0.099
Panicle Width	-0.065	-0.002	-0.033	0.044	-0.042	-0.001	0.624	-0.022	-0.012	-0.001	0.011	-0.004	-0.015	-0.040	0.018	0.459**
100 seed weight	0.011	0.000	-0.006	0.054	-0.028	-0.009	-0.119	0.116	-0.014	-0.007	-0.001	0.003	0.034	0.045	-0.011	0.068
Physiological maturity	0.042	0.000	0.016	-0.020	0.018	-0.007	-0.151	-0.031	0.051	0.024	-0.020	0.002	0.007	-0.008	0.001	-0.079
Fodder yield per plant	0.010	-0.001	-0.012	-0.020	-0.013	0.020	0.004	0.007	-0.011	-0.111	0.015	-0.004	-0.017	0.036	0.009	-0.088
SPAD value	-0.028	0.000	-0.013	-0.026	0.000	0.020	0.088	-0.002	-0.013	-0.022	0.075	-0.008	-0.001	0.011	0.009	0.090
Leaf Area	0.014	-0.002	-0.003	-0.011	0.015	0.034	0.079	-0.010	0.003	-0.015	0.019	-0.032	-0.011	0.010	-0.015	0.075
Seedling Vigour	0.022	-0.002	-0.017	0.095	-0.013	-0.019	-0.064	0.027	0.002	0.013	0.000	0.003	0.147	-0.042	-0.018	0.132*
Glossiness	-0.001	0.002	-0.012	0.053	-0.005	-0.016	0.107	-0.023	0.002	0.017	-0.004	0.001	0.027	-0.231	0.027	-0.055
Relative water content	-0.005	-0.002	0.001	0.006	0.019	0.020	-0.146	0.016	-0.001	0.013	-0.009	-0.006	0.034	0.080	-0.078	-0.057

Residual effect= 0.787

\*, \*\* denotes significance at 5% and 1% respectively

**Table 5:** Direct and indirect effect (Phenotypic level) of sixteen characters of *rabi* sorghum germplasm

Character	Days to 50% Flowering	Plant height	No of Primaries per Panicle	No. of grains per Primary branches	Panicle type	Panicle length	Panicle Width	100 seed weight	Physiological maturity	Fodder yield per plant	SPAD value	Leaf Area	Seedling Vigour	Glossiness	Relative water content	Grain Yield per Plant
Days to 50% Flowering	-0.025	0.001	-0.005	-0.002	-0.006	-0.003	-0.010	0.002	0.007	0.002	-0.004	0.003	0.004	0.000	0.000	0.123*
Plant height	-0.003	0.051	0.018	0.016	0.001	0.009	0.009	0.000	-0.002	0.003	0.001	0.006	0.007	-0.007	0.009	0.227*
No of Primaries per Panicle	0.009	0.014	0.041	0.030	0.005	0.012	0.016	0.003	-0.007	0.006	0.006	0.001	0.007	0.006	0.000	0.343**
No. of grains per Primary branches	0.012	0.056	0.133	0.182	0.024	0.002	0.029	0.035	-0.009	-0.012	-0.015	-0.007	0.055	0.032	0.003	0.297**
Panicle type	-0.029	-0.002	-0.015	-0.016	-0.125	0.036	-0.034	-0.024	0.016	-0.010	-0.002	0.013	-0.018	0.010	0.014	0.044
Panicle length	0.006	0.010	0.017	0.001	-0.017	0.059	0.001	-0.004	-0.001	0.009	0.009	0.015	-0.010	-0.004	0.009	0.092
Panicle Width	0.165	0.080	0.169	0.069	0.118	0.005	0.437	-0.078	-0.089	0.002	0.057	0.048	-0.023	0.063	-0.103	0.427**
100 seed weight	-0.008	0.000	0.007	0.020	0.020	-0.006	-0.018	0.103	-0.025	0.006	-0.002	-0.009	0.021	-0.018	0.014	0.062
Physiological maturity	-0.002	0.000	-0.001	0.000	-0.001	0.000	-0.001	0.000	0.007	0.000	-0.002	0.000	0.000	0.000	0.000	-0.090
Fodder yield per plant	0.009	-0.008	-0.019	0.009	-0.010	-0.020	-0.001	-0.008	0.023	-0.132	-0.026	-0.017	0.014	0.018	0.015	-0.091
SPAD value	0.006	0.001	0.006	-0.004	0.001	0.006	0.005	-0.001	-0.009	0.008	0.041	0.010	0.000	-0.002	-0.005	0.089
Leaf Area	-0.003	0.004	0.001	-0.001	-0.003	0.008	0.003	-0.003	0.002	0.004	0.007	0.030	-0.003	-0.001	0.006	0.073
Seedling Vigour	-0.013	0.013	0.015	0.028	0.013	-0.015	-0.005	0.019	0.005	-0.009	-0.001	-0.008	0.091	0.013	0.018	0.102*
Glossiness	-0.001	0.023	-0.025	-0.032	0.014	0.014	-0.026	0.032	-0.009	0.024	0.009	0.005	-0.027	-0.181	0.053	-0.044
Relative water content	-0.001	-0.016	0.001	-0.002	0.010	-0.013	0.021	-0.012	0.000	0.010	0.011	-0.018	-0.017	0.027	-0.090	-0.057

Residual effect= 0.832

\*, \*\* denotes significance at 5% and 1% respectively

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