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Correlation and path analysis studies in F_3 population of *Rabi* sorghum (*Sorghum bicolor* L. Moench)

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Abstract
An investigation was carried out with 20 F_3 progenies derived from four crosses *viz*., PR-105x B-35, CSV-29R x M-35-1, M-31-2B x 104-B, and RSLG-2438 x 774-B along with two checks namely Parbhani Moti and Parbhani Super Moti to assess the association of yield contributing traits and their direct and indirect effect on grain yield per plant. Results of correlation coefficient analysis indicated that Grain yield per plant show positive and significant association with plant height, days to physiological maturity, panicle breadth, no. of primaries per panicle, 1000 seed weight, fodder yield per plant, and harvest index at both genotypic and phenotypic level. The characters shows positive and direct effect on grain yield i. e. Plant height, Days to physiological maturity, Panicle length, Panicle breadth, 1000 Seed weight, Fodder yield per plant, Harvest index at genotypic and phenotypic level. The characters days to 50% flowering and no. of primaries per panicle show negative direct effect on grain yield per plant thus the present study indicated that the traits Plant height, Days to physiological maturity, Panicle breadth, 1000 Seed weight, Fodder yield per plant, Harvest index are important to increase the grain yield per plant hence these characters may be considered as selection indices in sorghum breeding programme.

Keywords: Path analysis studies, F_3 population, *rabi*, *Sorghum bicolor* L. Moench

Introduction
Sorghum (*Sorghum bicolor* (L.) Moench) is a crop with chromosome number 2n=20. The genus *Sorghum* belongs to the family Poaceae, sub-family Panicoideae, tribe Andropogoneae and subtribe Sorghastrum. Bicolor, Guninea, Kafir, Durra and Caudatum are the five fundamental races of Sorghum (Harlan and Dewet, 1972) [8]. Although *rabi* sorghum's yield in India is very low and highly variable from year to year, mostly because of the post-flowering drought, *rabi* sorghum is highly prized for the great quality of its grain. This crop typically experiences water stress both before and after flowering, which has a detrimental impact on yield (Kebede *et al.* 2001) [13]. According to Hall (1993) [9], the relative yield of a genotype under the same drought stress as another genotype is what is meant by the term "drought tolerance." The correlation coefficient aids in deciding the quantity and direction of characters to be taken into account when trying to increase grain yield in drought-stricken areas.

Materials and Methods
20 F_3 progenies derived from four crosses *viz*., PR-105x B-35, CSV-29R x M-35-1, M-31-2B x 104-B, and RSLG-2438 x 774-B along with two checks namely Parbhani Moti and Parbhani Super Moti were sown at Sorghum Research Station V.N.M.K.V. Parbhani. The experiment was conducted during *Rabi* 2022.
Observations were recorded on five randomly selected plants in each line from each replication for the following ten characters. Grain yield and its component traits: Days to 50 percent flowering (days), Plant height (cm), Days to physiological maturity (days), Panicle length (cm), Panicle breadth (cm), No. of primaries per panicle, 1000 Seed weight (g), Grain yield per plant (g), Fodder yield per plant (g), Harvest index.
The correlation coefficient studies were worked out as per the formula suggested by Johnson *et al.* (1955) [2]. The genotypic correlation coefficient between yield and its components were further partitioned into direct and indirect effects with the help of path coefficient analysis originally suggested by Wright (1921) [20] and further outlined by Dewey and Lu (1959) [5].

Table 1: List of F_3 progenies, parents, Checks of *rabi* Sorghum used for the study.

Sr. No. Crosses from which progeny derived	F_3 progenies	Sr. No. Crosses from which progeny derived	F_3 progenies	Parents
1.PR -105 x B- 35	F_3-1-1	11.M-31-2B x 104-B	F_3-3-1	104-B
2.	F_3-1-2	12.	F_3-3-2	M-31-2B
3.	F_3-1-3	13.	F_3-3-3	774-B
4.	F_3-1-4	14.	F_3-3-4	PR-105
5.	F_3-1-5	15.	F_3-3-5	RSLG-2438
6.CSV-29R x M-35-1	F_3-2-1	16.RSLG-2438 x 774-B	F_3 -4-1	CSV-29R
7.	F_3-2-2	17.	F_3-4-2	M-35-1
8.	F_3-2-3	18.	F_3-4-3	B- 35
9.	F_3-2-4	19.	F_3-4-4	
10.	F_3-2-5	20.	F_3-4-5	
Checks				
1.		Parbhani Moti		
2.		Parbhani Super Moti		

Results and Discussion

Grain yield per plant show positive and significant association with(table no. 2.) plant height (G=0.4923, P=0.5413), days to physiological maturity (G=0.2705, P=0.2596), panicle breadth (G=0.9090, P=0.8942), no. of primaries per panicle (G=0.9576, P=0.9268), 1000 seed weight (G=0.5525, P=0.6174), fodder yield per plant (G=0.5566, P=0.5869) and harvest index (G=0.8526, P=0.8008) at both genotypic and phenotypic level indicating that increase in grain yield is because of increase in one or more of the above characters. A less or more trend was observed by Swamy N. *et al.* (2018) [18], Tirkey *et al.* (2021) [19], Chavhan *et al.* (2022) [4], Khadakhabhavi *et al.* (2017) [16], Kavya *et al.* (2020) [15], Godbharle *et al.* (2010) [7] and Arunkumar *et al.* (2013) [1] obtained similar results for grain yield. Days to 50 percent flowering have significant and positive association with only days to physiological maturity (G=0.7945, P=0.7605). Panicle length has negative correlation with panicle breadth (G=-0.1683, P=0.0175), 1000 seed weight (G=-0.3977, P=-0.1926) and harvest index (G=-0.0137, P=0.0434), it means that increase in one character decreases the value of another.

Most of the characters had shows positive and direct effects on grain yield per plant i.e. Plant height (G= 0.0196, P= 0.0335), Days to physiological maturity (G=0.3210, P=0.0151), Panicle length (G=0.1895, P=0.0269), Panicle breadth (G=0.1110, P=0.0833), 1000 Seed weight (G=0.2754, P=0.0129), Fodder yield per plant (G=0.7659, P=0.5212), Harvest index (G=0.9374,P=0.7583) at genotypic and phenotypic level A Similar trend was also observed by earlier worker, Kavya *et al.* (2020) [15], Tirkey *et al.* (2021) [19], Kalpande *et al.* (2014) [14], Hundekar *et al.* (2016) [10], Prakash *et al.* (2010) [17], Akatwijukar *et al.* (2019) [3], Jain *et al.* (2014) [11].

Except days to 50 percent flowering (G=-0.3132, P=0.0077), No. of primaries per panicle (G=-0.7256, P=0.0021) shows negative direct effect on grain yield per plant. Deshmukh *et al.* (2021) [6] also observed similar results.

Table 2: Genotypic and Phenotypic correlation coefficient analysis for ten characters studied in *rabi* Sorghum

characters		Days to 50% flowering	Plant height (cm)	Days to physiological maturity	Panicle length (cm)	Panicle breadth (cm)	No. of primaries/panicle	1000 seed wt (g)	Fodder yield/plant (g)	Harvest index (%)	Grain yield/plant (g)
Days to 50% flowering	G	1.0000	0.0611	0.7945**	-0.1053	0.019	-0.0562	-0.0116	0.1617	-0.0401	0.0286
	P	1.0000	0.2432	0.7605**	0.0828	0.2283	0.1599	0.1181	0.2974*	0.0064	0.1829
Plant height (cm)	G		1.0000	0.0041	-0.3333**	0.4912**	0.5690**	0.4794**	0.7377**	0.13	0.4923**
	P		1.0000	0.1418	-0.0868	0.5460**	0.5745**	0.5386**	0.7609**	0.1031	0.5413**
Days to physiological maturity	G			1.0000	-0.1505	0.1719	0.1775	0.0384	-0.0386	0.3551**	0.2705*
	P			1.0000	-0.0098	0.2244	0.1978	0.0925	0.1394	0.2123	0.2596*
Panicle length (cm)	G				1.0000	-0.1683	0.0087	-0.3977**	0.1431	-0.0137	0.0535
	P				1.0000	0.0175	0.1621	-0.1926	0.2732*	0.0434	0.1886
Panicle breadth (cm)	G					1.0000	0.8925**	0.5360**	0.4986**	0.7828**	0.9090**
	P					1.0000	0.8592**	0.5863**	0.5405**	0.7003**	0.8942**
No. of primaries/ panicle	G						1.0000	0.6021**	0.5178**	0.8320**	0.9576**
	P						1.0000	0.6411**	0.5463**	0.7464**	0.9268**
1000 seed wt (g)	G							1.0000	0.1818	0.5330**	0.5525**
	P							1.0000	0.3166*	0.5175**	0.6174**
Fodder yield/plant (g)	G								1.0000	0.0441	0.5566**
	P								1.0000	-0.0065	0.5869**
Harvest index (%)	G									1.0000	0.8526**
	P									1.0000	0.8008**
Grain yield per plant	G										1.0000
	P										1.0000

* Significant at 5% level, ** Significant at 1% level

Table 3: Genotypic and Phenotypic path coefficient analysis for ten characters studied in *rabi* Sorghum

Characters		Days to 50% flowering	Plant height (cm)	Days to physiological maturity	Panicle length (cm)	Panicle breadth (cm)	No. of primaries/panicle	1000 seed wt (g)	Fodder yield/plant (g)	Harvest index (%)
Days to 50% flowering	G	-0.3132	-0.0191	-0.2489	0.0330	-0.0059	0.0176	0.0036	-0.0507	0.0125
	P	-0.0077	-0.0019	-0.0059	-0.0006	-0.0018	-0.0012	-0.0009	-0.0023	0.0000
Plant height (cm)	G	0.0012	0.0196	0.0001	-0.0065	0.0096	0.0112	0.0094	0.0145	0.0026
	P	0.0081	0.0335	0.0047	-0.0029	0.0183	0.0192	0.0180	0.0255	0.0035
Days to physiological maturity	G	0.2550	0.0013	0.3210	-0.0483	0.0552	0.0570	0.0123	-0.0124	0.1140
	P	0.0115	0.0021	0.0151	-0.0001	0.0034	0.0030	0.0014	0.0021	0.0032
Panicle length (cm)	G	-0.0200	-0.0632	-0.0285	0.1895	-0.0319	0.0016	-0.0754	0.0271	-0.0026
	P	0.0022	-0.0023	-0.0003	0.0269	0.0005	0.0044	-0.0052	0.0074	0.0012
Panicle breadth (cm)	G	0.0021	0.0545	0.0191	-0.0187	0.1110	0.0991	0.0595	0.0554	0.0869
	P	0.0190	0.0455	0.0187	0.0015	0.0833	0.0716	0.0488	0.0450	0.0583
No. of primaries /panicle	G	0.0408	-0.4129	-0.1288	-0.0063	-0.6476	-0.7256	-0.4369	-0.3757	-0.6036
	P	-0.0003	-0.0012	-0.0004	-0.0003	-0.0018	-0.0021	-0.0014	-0.0012	-0.0016
1000 seed wt (g)	G	-0.0032	0.1320	0.0106	-0.1095	0.1476	0.1658	0.2754	0.0500	0.1468
	P	0.0015	0.0070	0.0012	-0.0025	0.0076	0.0083	0.0129	0.0041	0.0067
Fodder yield/plant (g)	G	0.1238	0.5650	-0.0296	0.1096	0.3818	0.3966	0.1392	0.7659	0.0338
	P	0.1550	0.3966	0.0727	0.1424	0.2817	0.2847	0.1650	0.5212	-0.0034
Harvest index (%)	G	-0.0376	0.1218	0.3329	-0.0128	0.7338	0.7799	0.4996	0.0413	0.9374
	P	0.0049	0.0782	0.1610	0.0329	0.5310	0.5660	0.3924	-0.0049	0.7583
Grain yield/ plant (g)	G	0.0286	0.4923	0.2705	0.0535	0.9090	0.9576	0.5525	0.5566	0.8526
	P	0.1829	0.5413	0.2596	0.1886	0.8942	0.9268	0.6174	0.5869	0.8008

* Significant at 5% level, ** Significant at 1% level

Conclusion

The correlation coefficient aids in deciding the quantity and direction of characters to be taken into account when trying to increase grain yield. In the present investigation, significant and positive correlation of grain yield per plant was observed with characters *viz.* plant height, days to physiological maturity, panicle breadth, no. of primaries per panicle, fodder yield per plant, 1000 seed weight and harvest index at both genotypic and phenotypic level indicating that increase in grain yield is because of increase in one or more of the above characters. The positive direct and indirect effect of most of the above characters on grain yield conform that these characters may be considered as selection indices in sorghum breeding to enhance grain yield.

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