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RESEARCH PAPER

Association studies among yield and its attributing traits in coloured sorghum [*Sorghum bicolor* (L.) Moench]

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Abstract: The experiment was carried out at College of Agriculture Raichur, during *rabi* 2020 in augmented design to find out the correlation and path analysis in 120 coloured sorghum genotypes. Characters *viz*., panicle weight, 100 grain weight and panicle width showed significant positive correlation with grain yield at phenotypic level. Panicle weight, 100 grain weight and panicle length were negatively correlated with peduncle length at genotypic level. Among these traits panicle weight (r =0.760 and 0.829) showed high magnitude of positive association at both level with grain yield compared to other traits. Path analysis revealed positive direct effects of panicle weight, 100 grain weight, panicle width, peduncle length and plant height on grain yield per plant at phenotypic level. Panicle length, panicle weight and 100 grain weight and neck of panicle showed positive direct effects on grain yield at genotypic level. Selection for these traits would be effective in improving the grain yield.

Key words: Correlation, Coloured sorghum, Genotypes, Path analysis

Introducation

Sorghum [*Sorghum bicolor* (L.) Moench], popularly called as jowar, is the "king of millets" or "Great Millet" and is the fifth most important cereal crop in the world after rice, wheat, maize and barely, in terms of production and utilization. The word sorghum is derived from the latin word "Sorgo" which means "Raising above". It is also called as jola, jowar, cholam in India. It is called as a failsafe crop and camel of crops, because of its drought tolerance and heat tolerance property and also its high photosynthetic efficiency. So, it is considered as an important staple food crop in arid and semi-arid regions of the world (Anagholi *et al*., 2000).

Sorghum is grown in India, in an area of about 4.09 m ha with production of 3.48 million tonnes and productivity of 845 kg/ha. In Karnataka, it is grown in 0.94 m ha with production of 0.89 million tonnes and productivity of 945 kg/ha (Anon., 2019). Sorghum is originated in Africa. It is an often cross pollinated, diploid (2n = 20) and C_4 grass plant species, which belongs to the family "Graminae" and tribe "Andropogeneae". Cultivated sorghum has five basic races, *viz*., bicolor, durra, guinea, caudatum and kafir and ten intermediate races.

Correlation coefficients nearly describe the existence of association between characters. The method of path coefficient developed by Wright (1921) is helpful in assessing whether association of characters with yield is having direct or indirect effect on yield or is a consequence in indirect effect through some other traits.

Yield is a complex character, which depends upon many independent contributing characters. Knowledge on type of association between yield and its components themselves greatly help in evaluating the contribution of different components towards yield, information on the nature of association between yield and its components help in simultaneous selection for many characters associated with yield improvements (Swamy *et al*., 2018). This study was undertaken to estimate the direct and indirect effect of traits on grain yield and association among yield traits by utilizing the correlation and path analysis.

Material and methods

The experiment was conducted at College of Agriculture, Raichur during *rabi*, 2020. The experimental material comprising of 120 genotypes of sorghum with different colours, which included exotic collections and also indigenous collections obtained from R.S. Paroda gene bank, ICRISAT, Patancheru and some indigenous collections from UAS, Raichur. The five checks were used in the study are M 35-1, Paiyur 2, AKJ 1, IS 2312 and DJ 6514.

The released check varieties M 35-1 (white pericarp), AKJ 1 (red) and Paiyur 2 (red) were used for comparison for grain yield and yield contributing characters and antioxidant property. The other two checks were used for shootfly incidence comparison in the normal condition. IS 2312 is resistance to shootfly and DJ 6514 is susceptible. M 35-1, IS 2312 and DJ 6514 were obtained from ARS, Hagari, UAS, Raichur, AKJ 1 was obtained from RARS, Vijayapur, UAS, Dharwad and Paiyur 2 was obtained from ARS, Coimbatore. The list of genotypes used for the study is presented in Table 1.

One hundred and twenty genotypes of sorghum [*Sorghum bicolor* (L.) Moench] along with five checks were sown during *rabi,* 2020 in Augmented design. Each entry was sown in 3 blocks. Each block was of 4 m length with uniform spacing of 45 cm between rows and 15 cm between plants. All the necessary package of practices and need based plant protection measures were followed to raise the healthy crop. During the period of experiment, the crop was not received any rainfall. The two protective irrigations were given to raise the healthy crop.

Sl. No.	Genotype	Sl. No.	Genotype
1	IS 522	61	IS 28015
2	IS 2502	62	IS 28017
3	IS 2582	63	IS 28049
4	IS 2618	64	IS 28050
5	IS 3579	65	IS 28210
6	IS 3817	66	IS 28217
7	IS 6508	67	IS 28224
8	IS 7013	68	IS 28230
9	IS 7527	69	IS 28176
10	IS 8222	70	IS 28198
11	IS 8792	71	IS 28200
12	IS 9664	72	IS 28202
13	IS 9667	73	IS 28237
14	IS 11180	74	IS 28243
15	IS 12643	75	IS 28244
16	IS 14094	76	IS 28250
17	IS 14897	77	IS 28265
18	IS 14904	78	IS 28791
19	IS 14905	79	IS 28792
20	IS 15098	80	IS 28966
21	IS 16006	81	IS 29031
22	IS 16169	82	IS 28982
23	IS 16202	83	IS 29012
24	IS 16310	84	IS 29013
25	IS 16316	85	IS 29014
26	IS 16398	86	IS 29032
27	IS 17591	87	IS 29033
28	IS 18301	88	IS 29052
29	IS 18639	89	IS 29055
30	IS 18679	90	IS 31706
31	IS 19298	91	IS 30722
32	IS 19299	92	IS 31731
33	IS 21868	93	IS 30736
34	IS 22436	94	IS 30754
35	IS 22897	95	IS 30800
36	IS 22942	96	IS 30802
37	IS 19498	97	IS 30781
38	IS 20301	98	IS 31718
39	IS 20842	99	IS 31732
40	IS 21835	100	IS 31906
41	IS 23890	101	IS 32072
42	IS 23916	102	IS 32079
43	IS 23950	103	IS 32121
44	IS 23953	104	IS 32163
45	IS 22949	105	IS 32165
46	IS 22970	106	IS 32185
47	IS 23864	107	IS 33158
48	IS 23865	108	IS 33159
49	IS 28000	109	IS 33310
50	IS 28001	110	IS 33317
51	IS 28009	111	IS 33323
52	IS 28014	112	IS 33336
53	IS 23954	113	IS 33343
54	IS 23955	114	IS 34723
55	IS 25040	115	IS 35642
56	IS 24001	116	IS 35823
57	IS 28056	117	IS 35838
58	IS 28065	118	IS 38527
59	IS 28074	119	IS 39564
60	IS 28172	120	IS 40175

Sl. No.	Checks	Sl. No.	Checks
1	M 35-1	4	IS 2312
2	AKJ 1	5	DJ 6514
3	Paiyur 2		

Results and discussion

The study of correlations helps the plant breeder to know how the improvement of one character will bring the simultaneous improvement of other characters. Correlation coefficients determines the magnitude of linear association between the pairs of characters and estimates the degree of closeness and linear relationship between the two variables. Hence, correlation analysis is important to know the mutual relationship between the two variables. Yield is a polygenically inherited trait with low heritability and is highly fluctuated by environmental effects; hence direct selection is not desirable for its improvement. Hence, magnitude and direction of association of component characters with yield acts as a pre-requisite for successful breeding programmes.

The phenotypic and genotypic correlation coefficients for ten parameters which includes yield and yield attributing characters for the 120 genotypes along with five checks was worked out in order to determine the nature and extent of association with each component. The results are presented in Table 2.

At phenotypic level, the grain yield per plant was correlated positively with panicle weight (0.760), 100 grain weight (0.301) and panicle width (0.190). At genotypic level, the grain yield per plant was correlated positively with panicle weight (0.829), 100 grain weight (0.371) and panicle length (0.216) and was negatively correlated with peduncle length (-0.205).

The positive correlation of yield attributing characters with grain yield indicates that increase in these characters will make improvement in the grain yield. So in the present study selection and improvement in the characters *viz*., panicle length, panicle width, 100 grain weight and panicle weight will increase grain yield. The negative correlation of peduncle length with grain yield indicates that selection of genotypes with less peduncle length will increase the grain yield. The results were in agreement with Sushmita and Selvi (2012), Nyadanu and Dikera (2014), Amare *et al*. (2015), Khadakabhavi *et al.* (2017), Zinzala *et al*. (2018) and Goswami *et al*. (2020).

The determination of correlation alone may be often misleading due to mutual cancellation of component traits, so it is mandatory to study the path co-efficient analysis. Path coefficient analysis shows a relative contribution of different characters towards grain yield. Genotypic correlation and phenotypic correlation was partitioned into direct and indirect effects to observe the direct effect of a trait on grain yield and its indirect effect through other characters. Direct and indirect effects on grain yield at phenotypic and genotypic level represented in Table 3.

At phenotypic level, five out of ten characters studied showed positive and direct effect on grain yield (Table 3 and Fig.1). The characters panicle weight (0.7291) had showed high magnitude of positive direct effect on yield, but remaining four

Table 2. Phenotypic and genotypic correlation coefficients for yield and yield attributing characters

Character		PH	DFF	DM	NP	PEDL	PWD	PL	100GW	PW	GYPP
PH	P	1	-0.002	0.003	0.107	0.310**	0.177*	0.282**	0.1604	0.056	0.104
	G		-0.0465	-0.002	0.105	0.506**	0.024	0.421**	0.237**	0.091	0.069
DFF	P		1	0.005	0.001	-0.103	-0.099	-0.136	0.190*	0.160	0.124
	G			-0.152	0.005	-0.086	-0.169	-0.141	0.229*	0.211*	0.0934
DM	P			1	-0.087	-0.071	0.164	0.138	0.099	0.064	0.030
	G				-0.092	-0.045	0.117	0.300**	0.189*	0.1	-0.014
NP	P				1	0.587**	-0.163	0.128	-0.055	-0.112	-0.080
	G					0.647**	-0.264**	0.173	-0.0579	-0.123	-0.107
PEDL	P					1	-0.180*	0.304**	-0.104	-0.037	-0.002
	G						-0.348**	0.521**	-0.165	-0.144	-0.205*
PWD	P						1	-0.042	0.137	0.155	0.190*
	G							0.166	0.289**	0.111	-0.062
PL	P							1	-0.041	0.042	-0.028
	G								-0.106	0.197*	0.216*
100GW	P								1	0.279**	0.301**
	G									0.294**	0.371**
PW	P									1	0.760**
	G										0.829**
GYPP	P										1

** = Significant at 1 per cent * = Significant at 5 per cent
PH= Plant height (cm) DFF = Days to 50 per cent flowering DM = Days to maturity NP= Neck of panicle (cm)
PEDL= Peduncle length (cm) PWD=Panicle width (cm) PL= Panicle length (cm) 100GW=100 Grain weight (g)
PW=Panicle weight (g) GYPP= Grain yield per plant (g)

Table 3. Phenotypic and genotypic path coefficient analysis of different yield attributing characters on grain yield

Character		PH	DFF	DM	NP	PEDL	PWD	PL	100 GW	PW	r_{gypp}
PH	P	0.0407	-0.0001	0.0001	0.0044	0.0126	0.0072	0.0115	0.0065	0.0023	0.1039
	G	-0.0248	0.0012	0.0001	-0.0026	-0.0125	-0.0006	-0.0104	-0.0059	-0.0023	0.0687
DFF	P	0.0000	-0.0058	0.0000	0.0000	0.0006	0.0006	0.0008	-0.0011	-0.0009	0.1244
	G	0.0123	-0.2648	0.0402	-0.0012	0.0228	0.0448	0.0374	-0.0606	-0.0559	0.0934
DM	P	-0.0001	-0.0001	-0.0222	0.0019	0.0016	-0.0036	-0.0031	-0.0022	-0.0014	0.0298
	G	0.0008	0.0524	-0.3451	0.0317	0.0153	-0.0405	-0.1033	-0.0652	-0.0345	-0.0141
NP	P	-0.0019	0.0000	0.0015	-0.0175	-0.0103	0.0029	-0.0022	0.001	0.002	-0.0800
	G	0.0174	0.0008	-0.0152	0.1655	0.1071	-0.0438	0.0287	-0.0096	-0.0204	-0.1069
PED.L	P	0.0205	-0.0068	-0.0047	0.0388	0.0661	-0.0119	0.0201	-0.0069	-0.0024	-0.0015
	G	-0.3593	0.0611	0.0316	-0.4601	-0.7109	0.2476	-0.3700	0.1173	0.1021	-0.205*
PWD	P	0.0117	-0.0066	0.0109	-0.0108	-0.012	0.0663	-0.0028	0.0091	0.0103	0.190*
	G	-0.0137	0.0974	-0.0677	0.1523	0.2007	-0.5761	-0.0958	-0.1664	-0.0640	-0.0620
PL	P	-0.0223	0.0108	-0.0109	-0.0101	-0.0241	0.0033	-0.0792	0.0033	-0.0033	-0.0282
	G	0.2729	-0.0917	0.1943	0.1125	0.3376	0.1078	0.6487	-0.0688	0.1277	0.216*
100GW	P	0.0141	0.0167	0.0087	-0.0049	-0.0091	0.0121	-0.0036	0.0878	0.0245	0.301**
	G	0.1040	0.1006	0.0831	-0.0254	-0.0725	0.1270	-0.0466	0.4396	0.1294	0.371**
PW	P	0.0411	0.1163	0.0464	-0.0817	-0.0269	0.113	0.0303	0.2031	0.7291	0.760**
	G	0.0591	0.1365	0.0646	-0.0796	-0.0928	0.0718	0.1273	0.1903	0.6464	0.829**

Phenotypic residual value = 0.233 Genotypic residual value = 0.138 ** = Significant at 1 per cent *= Significant at 5 per cent
PH= Plant height (cm) DFF = Days to 50 per cent flowering DM = Days to maturity NP= Neck of panicle (cm)
PEDL= Peduncle length (cm) PWD=Panicle width (cm) PL= Panicle length (cm) 100GW=100 Grain weight(g)
PW=Panicle weight (g) r_{gypp} = correlation value for grain yield per plant.

characters, 100 grain weight (0.0878), panicle width (0.0663), peduncle length (0.0661) and plant height (0.0407) were showed low magnitude of positive direct effects on grain yield. The high magnitude of positive direct effect of panicle weight on grain yield indicated the true relationship of this character with grain yield as it was showed significant positive correlation with grain yield. So, selection of this character would be effective in improving the grain yield. The remaining characters like panicle length (-0.0792), days to maturity (-0.0222), neck of panicle (-0.0175) and days to 50 per cent flowering (-0.0058) were showed negative direct effects of low magnitude on grain yield. Similar findings were reported by Susmita and Selvi (2012), Arunkumar (2013), Amare *et al*. (2015), Khandelwal *et al*. (2015) and Zinzala *et al*. (2018).

At genotypic level, four characters showed positive direct effects on grain yield (Table 3 and Figure 2). The characters like panicle length (0.6487), panicle weight (0.6464) and 100 grain weight (0.4396) were showed high magnitude of positive direct effects on grain yield and the character neck of panicle showed

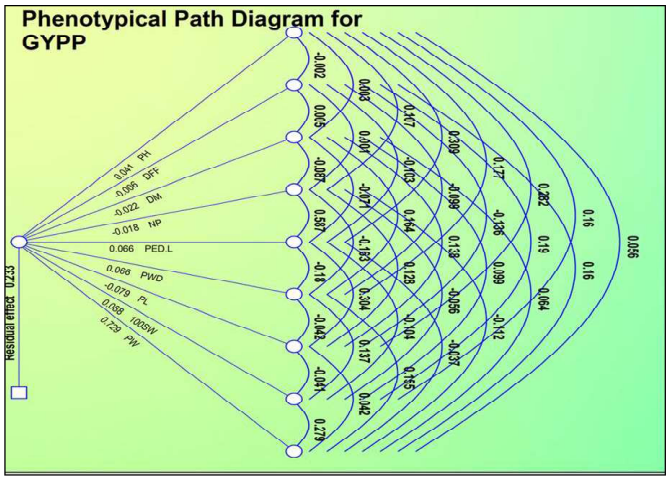

Fig. 1. Phenotypic path diagram showing influence of characters on grain yield per plant (GYPP) in coloured sorghum genotypes

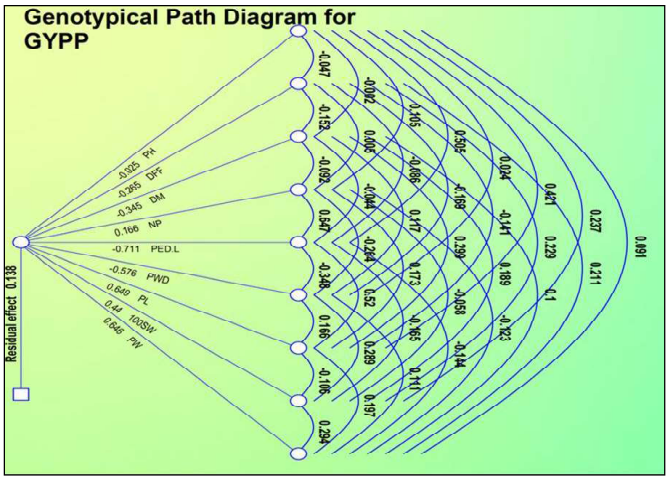

Fig. 2. Genotypic path diagram showing influence of characters on grain yield per plant (GYPP) in coloured sorghum genotypes

low magnitude (0.1655). The positive significant correlation and high magnitude of direct effects of the characters panicle length, panicle weight and 100 grain weight on grain yield indicated the true relationship of these characters and selection for these characters would be effective in improving the grain yield. While, the characters like peduncle length (-0.7109), panicle width (-0.5761) and days to maturity (-0.3451) showed high magnitude and days to 50 per cent flowering (-0.2648) and plant height (-0.0248) were showed low magnitude of negative direct effects on grain yield. The significant negative correlation of peduncle length and negative direct effect of high magnitude on grain yield explained the true relationship of this character on grain yield and selection for less peduncle length improves the grain yield.

Conclusion

After thorough study of correlation and path analysis, the traits *viz*., panicle length, panicle width, panicle weight and 100 grain weight should be given more importance for these traits during selection of genotypes for grain yield improvement. The indirect effect of yield attributing characters on grain yield per plant was explained for the characters which showed significant correlation with yield at genotypic and phenotypic levels. Significant positive correlation of yield with the characters panicle width, panicle weight and 100 grain weight was found at phenotypic level and with panicle length, panicle weight, 100 grain weight at genotypic level and negative correlation with peduncle length at genotypic level.

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