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IDENTIFICATION OF DUAL TYPE SORGHUM GENOTYPES BASED ON CORRELATION AND PATH COEFFICIENT STUDIES

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SUMMARY

Knowledge about the relationship between green and dry biomass yield, grain yield, and quality traits is important for any dual-purpose sorghum development program. Thus, the objective of this study was to determine correlations and path-coefficients between green fodder yield, stover yield, grain yield and quality traits. The field experiment was conducted at Research Area of Forage Section, Department of Genetics and Plant Breeding, CCS HAU, Hisar during *kharif* 2019 by using 30 genotypes to study the variability, heritability, genetic advance and genotypic and phenotypic correlations on the basis of nineteen agro-morphological and biochemical parameters. Analysis of variance showed highly significant variation for 19 quantitative parameters under study. Significant variation among all the genotypes was recorded for all the characters. High heritability coupled with high genetic advance was reported for green fodder yield, stover yield and protein yield. In correlation studies, it was observed that green fodder yield was found positively associated with plant height, leaf length, leaf breadth, stem diameter, stover yield, dry fodder yield, grain yield, panicle length, 100 grain weight, protein content and protein yield. HCN content was negatively correlated with green fodder yield and dry fodder yield. In path coefficient analysis, green fodder yield (0.4165), grain yield (0.7330), stover yield (0.6543), plant height (0.6983), TSS content (0.3873) had high positive direct effect on dry fodder yield. However, traits like panicle length (-1.0237), no. of tillers/plant (-0.5931), leaf breadth (-0.4657) and stem diameter (-0.4657) had shown negative direct effect on DFY.

Key words : Green fodder yield, dual purpose, grain yield, quality

Sorghum is originated in Africa and belongs to family Poaceae and genus Sorghum. It is a diploid crop having some perennial ancestors and often cross-pollinated in nature. Cultivated sorghum is diploid having chromosome number 20 with genome size approx. 730-megabase (Paterson. *et al*., 2009). It is the fifth most important grain crop in the world. Sorghum was discovered by Linnaeus in 1753 and referred as Holus in literature. It is mainly useful as human food but also used as animal fodder having good nutritional composition. Sorghum has high nutritional value with high levels of unsaturated fats, proteins, fiber and minerals like potassium, phosphorus, calcium and iron. India is the third largest sorghum producer after Nigeria and United States of America, with 6.25 million hectares of area under sorghum cultivation, and with a total production of 5.98 million tones. Sorghum is grown in more than 86 countries in area of 38 million ha in annual production and grain production of sorghum is about 58 million tones. Sorghum production in the world is about 1.5 tonnes/ha (FAO, 2018).The dual purpose sorghum includes all those sorghum genotypes which produce sufficient quality grains for human consumption and fodder for animal feed. Sorghum is a good choice of fodder for farming community due to good quality, high yield, drought tolerance, regeneration potential are some important factors having great impact on the livestock industry. Being a drought tolerant crop it is an important cereal crop in the semi-arid tropics. Sorghum can also grow in those semi-arid areas in which other cereals cannot grow successfully.

Success of dual-purpose sorghum breeding programme for grain and fodder depend on the understanding of the relationship between the two associated traits. Generally forage types are shy seeders means improvement of grain yield in fodder types is very difficult task. Understanding the grain yield and forage relationship is important because it helps plant breeders to formulate and optimize breeding strategies for developing dual type in sorghum. Trait association is studied by using simple correlation coefficients. This measures simple linear relationships among traits, that is, mutual association irrespective of cause and effect. Thus alone correlation coefficients do not give a clear representation of relationships (Makanda,2017). This necessitates a further breakdown of the correlation coefficients into non-linear connecting paths of influence, called path-coefficients. Path coefficients give both the direct and indirect influences of individual traits to a dependent variable.

This is based on the fact that as the number of parameters influencing a particular dependent variable increase, so does the interdependence among those parameters. This information is critical because it informs a breeder's choice of direct or indirect selection capitalizing on correlated responses. Nevertheless, there are no such reports elucidating this relationship for quality, green fodder and grain yield traits in dual-purpose sorghums.Further, results obtained elsewhere do not necessarily reflect same relationships in a different environment. The objective of this study was to establish ther elationship between green fodder yield, grain yield and quality traits in dual type sorghum grown in North Western Haryana.

MATERIALS AND MEHTODS

The experimental material consists of 30 diverse genotypes of sorghum was sown in Randomized complete block design (RBD) with 3 replications during *kharif* season of 2019 at Research Area of Forage Section, Department of Genetics and Plant Breeding CCS Haryana Agricultural University, Hisar. It is situated in semi-arid sub-tropical region at 29° 10′N latitude and 75° 46′E longitude with elevation of 215.52 m above mean sea level. Each genotype was grown in 2 meter length of 2 rows with 30 cm spacing between rows and 15 cm spacing between plants. All the recommended cultural and plant protection practices were adopted for raising the forage sorghum crop (Jain & Patel, 2016). Observations were taken on five randomly selected competitive plants of each genotype in each plot for nineteen different agronomical and biochemical traits. The data for all the traits were recorded at the time of 50% flowering. HCN (mg/g fresh weight) was estimated from the young shoots after 30 days of sowing by method suggested by Gilchrist *et al.* (1967). Refractometer was used to measure TSS content. 500gm green fodder samples was taken from each genotype at 50% flowering and dried in field and then in the oven. After drying samples were grinded and used to estimate crude protein. Crude protein content (%) was estimated by Micro-Kjeldhal's method.

The mean values over replications were subjected for statistical analysis. Analysis of variance (ANOVA) for the observations recorded on different characteristics was carried out as per the standard procedure suggested by Panse and Sukhatame (1995). Genotypic and phenotypic coefficient of variation and heritability were estimated as suggested by Singh and Choudhary (1977) while genetic advance was computed as per the procedure of Johnson et al. (1995). Correlation coefficient was estimated as per method given by Al-Jibouri et al. (1958) and path analysis as per Dewey and Lu (1959) for all the traits under study.

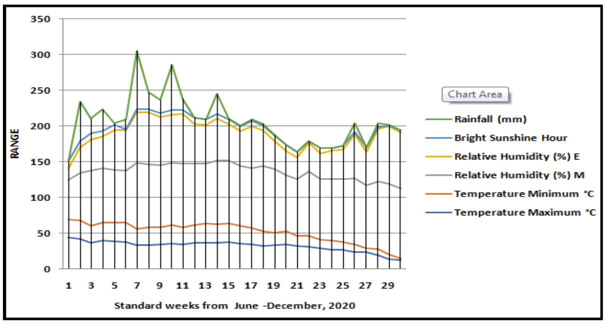

Fig. 1. Temperature, relative humidity and rainfall received from June-Dec. 2019.

RESSULTS AND DISCUSSION

Analysis of variance

The mean sum of squares due to genotypes were recorded to be highly significant for all the 13 characters under study except no of tiller per plant, L/S ratio, Leaf breadth, 100 grain weight, TSS content and protein content (Table 1). This indicated prevalence of enough genetic variability in the material under study for selection and improvement of genotypes for green fodder yield, grain yield, quality and their contributing traits. This also indicates its suitability for further statistical analysis for all the characters under study.

Estimation of GCV and PCV

Estimates of genetic parameters *viz.*, genotypic and phenotypic coefficient of variation, heritability and genetic advance as percent of mean

TABLE 1
List of genotype use in study

S. No.	Genotype	S. No.	Genotype
1.	HC-136	16.	CSV-15
2.	PC-3	17.	PC-1080
3.	ICSV-700	18.	G-46
4.	PC-7	19.	S-713
5.	PC-5	20.	SH-1591
6.	IS-651	21.	SH-1562
7.	CSV21F	22.	CSV32F
8.	S-722	23.	SH 1574
9.	HC-171	24.	CSV30F
10.	S-652	25.	IS2205
11.	HC-308	26.	HC260
12.	GFS-5	27.	SH1532
13.	SPV-2451	28.	PC 4
14.	HJ-513	29.	SH1485
15.	HJ-541	30.	UTMC1539

are presented in Table 2. Heritability and genetic advance as mean percentage (GAM) is a strong tool for developing good selection indices. In this experiment, high heritability followed high genetic advance as percent of mean was recorded the traits of plant height, panicle length, green fodder yield, stover yield, dry fodder yield, and protein yield (Table 2). These results on heritability and GAM suggests that selection based on highly heritable traits *viz.*, plant height, panicle length, green fodder yield, stover yield, dry fodder yield, and protein yield is quite beneficial during the forage sorghum breeding programme. These results on the parameters of genetic variability are similar with those reported by Vijaylaxmi *et al.* (2019).

Low magnitude GCV was observed for the traits *viz* .days to 50% flowering, days to maturity, no. of leaves per plant, leaf length, leaf breadth, L/S ratio, grain yield, 100 grain weight, TSS content, protein content. The higher magnitude of GCV was reported for panicle length, green fodder yield, stover yield, HCN content, protein yield. Remaining traits *viz.* plant height, no of tiller per plant, stem diameter and dry fodder yield were showing moderate magnitude of GCV. Kalpande*et al.* (2014) also reported higher values of PCV value than the corresponding GCV value for all the investigated traits in forage sorghum. Furthermore, Patil *et al.* (2014) and Vijaylaxmi *et al.* (2019) also reported a varying level of GCV and PCV for various traits in forage sorghum along with a wider difference between both values.

Correlation coefficient analysis

The correlation coefficient is a measure to estimate the extent and direction of association among the studied characters. This knowledge about the relationship among the different traits is very essential to formulate a breeding programme aimed at achieving

TABLE 2
Estimates of GCV, PCV, Heritability and Genetic advance as % of mean for different traits in sorghum

S. No.	Character	Heritability (%)	GCV (%)	PCV (%)	GA as % of mean
1.	Days to 50 % flowering	97.19	3.85	3.9	7.83
2.	Days to maturity	82.35	2.4	2.64	4.49
3.	Plant height	86.87	13.6	14.59	26.11
4.	No of tiller per plant	49.73	14.12	20.03	20.52
5.	No of leaves per plant	36.04	8.15	13.57	10.08
6.	Leaf length	79.8	4.63	5.18	8.53
7.	Leaf breadth	94.33	7.25	7.46	14.51
8.	Stem diameter	57.59	12.29	16.19	19.21
9.	L/S ratio	24.13	4.68	9.54	4.74
10.	Panicle length	85.84	22.68	24.47	43.28
11.	Green fodder yield	84.84	23.4	25.41	44.41
12.	Stover yield	84.18	22.07	24.05	41.71
13.	Dry fodder yield	93.65	17.01	17.58	33.91
14.	Grain yield	62.85	8.66	10.92	14.14
15.	100 grain weight	38.92	8.62	13.81	11.07
16.	TSS content	25.99	8.12	15.94	8.53
17.	HCN content	73.26	66.25	77.41	11.82
18.	Protein content	75.54	5.42	6.24	9.71
19.	Protein yield	85.9	24.65	26.59	47.08

a desirable combination of various traits. These relationships are also useful for indirect selection of various desirable traits. It was also observed that phenotypic coefficient of variation had higher magnitude than genotypic coefficient of variation for all the traits, indicating the effects of environment of the traits Table 3. In the present experiment, green fodder yield (GFY) was found to be positively associated with plant height (PH), leaf length (LL), leaf breadth (LB), stem diameter (SD), stover yield (SY), dry fodder yield (DFY), grain yield (GY), panicle length (PL),100 grain weight (GW), crude protein content (CP%) and crude protein yield (CPY) at significance level *($p<0.01$)*, which indicates that selection of these traits during breeding program will improve green fodder yield. Furthermore, dry fodder yield (DFY) showed a significantly positive association with plant height (PH), leaf length (LL), leaf breadth (LB), stem diameter (SD), stover yield (SY), green fodder yield (DFY), grain yield (GY), panicle length (PL), 100 grain weight (GW), protein content (CP%) and crude protein yield (CPY) indicating the importance of these traits in breeding programme aimed at improving DFY. A significant and negative correlation of green fodder yield ($p<0.05$) and dry fodder yield ($p<0.01$) percentage with HCN content was also reported. In addition to GFY & DFY, qualitative traits such as HCN content, crude protein (CP) and TSS content are also major characters in forage sorghum breeding program due to their direct effect on the productivity of livestock. The HCN content showed a significant and negative association with no of tillers per plant ($p<0.01$) and stem diameter (SD) ($p<0.01$), green fodder yield (GFY) ($p<0.01$), stover yield (SY) ($p<0.0$), dry fodder yield(DFY), grain yield (GY))($p<0.01$), panicle length(PL)($p<0.01$),100grain weight (GW) ($p<0.01$) and protein yield (PY) ($p<0.01$) and a significantly positive association with days to 50% flowering (DF) ($p<0.01$). CP showed a significantly positive correlation with leaf length (LL) ($p<0.01$), leaf breadth (LB) ($p<0.01$) green fodder yield (GFY) ($p<0.01$), stover yield (SY) ($p<0.01$), dry fodder yield (DFY), grain yield (GY), 100 grain weight ($p<0.01$), TSS content ($p<0.01$) and protein yield (CPY) ($p<0.01$). CPY was found to be positively associated with the traits PH, SD, PL, PH , LL, LB, GFY, SY, DFY, PL, GW, and CP ($p<0.01$) while the association with HCN content was significantly negative ($p<0.05$). Furthermore, TSS content had a significantly positive association with LB, LL, GW and CP.

Regarding the inter-correlation between important agronomic and qualitative traits, GFY was significantly positive correlated with dry fodder yield ($p<0.01$), plant height ($p<0.01$), no. of leaves/plant ($p<0.01$), leaf length ($p<0.01$), leaf breadth ($p<0.01$), L/S ratio($p<0.01$), stover yield ($p<0.01$), grain yield ($p<0.01$), 100 grain weight ($p<0.01$) whereas, among quality traits crude protein showed significantly positive correlation ($p<0.05$). The crude protein content had significantly negative association ($p<0.01$) with HCN. The results from the present study are in agreement with the reports by Jain & Patel, 2013, Singh *et al.* 2016. Slight contradictions between these previous studies and the present one might be due to the difference between the study material, methods and environmental conditions.

Path coefficient analysis

Correlation coefficient provides the degree of association betweentwo or more traits but it fails in providing the information about the individual causal effects. Therefore, path coefficient analysis is used to partition total correlation coefficient into direct and indirect effects and as a measure to assess the relative importance of the causal factor, individually. Considering the dry fodder yield as a dependent trait the effect of other (independent) traits was studied. The residual effect was 0.063 indicating the explanation of dependent variable by all the independent variables (Table 4).

In the present investigation, green fodder yield (0.4165), grain yield (0.7330), stover yield (0.6543), plant height (0.6983), TSS content (0.3873) had high positive direct effect on dry fodder yield. However, traits like panicle length (-1.0237), no. of tillers/plant (-0.5931), leaf breadth (-0.4657) and stem diameter (-0.4657) had shown negative direct effect on DFY (Table 4). The contribution of other traits was found to be negligible either in positive or negative directions. These results indicated that GFY, stover yield and plant height can be used as positive selection indices for breeding for higher dry fodder yield. In addition to these traits a breeder should also consider the negative effect of panicle length, stem diameter on dry fodder yield during forage sorghum breeding.

Indirect effects of various traits on dry fodder yield, like days to maturity, no. of leaves/plant, leaf length, leaf breadth, panicle length, stover yield exhibited positive effect *via* dry fodder yield and negative effect *via* no. of tillers per plant, leaf breadth, protein content, HCN content.

TABLE 3
Genotypic (above diagonal) and phenotypic (below diagonal) correlation matrix between different traits of sorghum

	DF	DM	PH	NT/P	NL/P	LL	LB	SD	L/S	GFY	SY	DFY	GY	PL	GW	TSS	HCN	CP	CPY
DF	1	0.855**	0.044^{NS}	-0.071^{NS}	-0.102^{NS}	0.025^{NS}	-0.427**	-0.054^{NS}	-0.026^{NS}	-0.199^{NS}	-0.214*	-0.186^{NS}	-0.467**	0.107^{NS}	-0.244*	0.035^{NS}	0.234*	-0.052^{NS}	-0.172^{NS}
DM	0.855**	1	-0.005^{NS}	0.003^{NS}	-0.001^{NS}	-0.052^{NS}	-0.423**	-0.059^{NS}	0.068^{NS}	-0.247*	-0.264*	-0.240*	-0.470**	0.120^{NS}	-0.261*	-0.007^{NS}	0.157^{NS}	-0.145^{NS}	-0.243*
PH	0.044^{NS}	-0.005^{NS}	1	-0.068^{NS}	-0.052^{NS}	0.154^{NS}	0.131^{NS}	0.152^{NS}	0.014^{NS}	0.416**	0.382**	0.378**	0.366**	0.357**	0.020^{NS}	-0.090^{NS}	-0.050^{NS}	0.016^{NS}	0.339**
NT/P	-0.071^{NS}	0.003^{NS}	-0.068^{NS}	1	0.797**	0.098^{NS}	0.082^{NS}	0.018^{NS}	0.116^{NS}	-0.006^{NS}	0.013^{NS}	0.019^{NS}	-0.013^{NS}	-0.112^{NS}	-0.024^{NS}	0.061^{NS}	-0.224*	0.001^{NS}	0.016^{NS}
NL/P	-0.102^{NS}	-0.001^{NS}	-0.052^{NS}	0.797**	1	0.096^{NS}	0.071^{NS}	0.048^{NS}	0.139^{NS}	0.076^{NS}	0.080^{NS}	0.106^{NS}	0.061^{NS}	-0.047^{NS}	-0.053^{NS}	0.007^{NS}	-0.190^{NS}	0.018^{NS}	0.100^{NS}
LL	0.025^{NS}	-0.052^{NS}	0.154^{NS}	0.098^{NS}	0.096^{NS}	1	0.291**	0.134^{NS}	0.250*	0.306**	0.303**	0.305**	0.107^{NS}	0.078^{NS}	0.180^{NS}	0.237*	-0.025^{NS}	0.468**	0.380**
LB	-0.427**	-0.423**	0.131^{NS}	0.082^{NS}	0.071^{NS}	0.291**	1	0.143^{NS}	-0.020^{NS}	0.419**	0.412**	0.419**	0.529**	0.065^{NS}	0.416**	0.248*	-0.169^{NS}	0.334**	0.448**
SD	-0.054^{NS}	-0.059^{NS}	0.152^{NS}	0.018^{NS}	0.048^{NS}	0.134^{NS}	0.143^{NS}	1	0.234*	0.306**	0.298**	0.306**	0.326**	0.249*	0.274**	-0.073^{NS}	-0.238*	0.120^{NS}	0.313**
l/S	-0.026^{NS}	0.068^{NS}	0.014^{NS}	0.116^{NS}	0.139^{NS}	0.250*	-0.020^{NS}	0.234*	1	0.175^{NS}	0.194^{NS}	0.156^{NS}	0.072^{NS}	-0.097^{NS}	-0.043^{NS}	-0.055^{NS}	-0.029^{NS}	0.003^{NS}	0.132^{NS}
GFY	-0.199^{NS}	-0.247*	0.416**	-0.006^{NS}	0.076^{NS}	0.306**	0.419**	0.306**	0.175^{NS}	1	0.993**	0.984**	0.502**	0.271**	0.304**	0.142^{NS}	-0.292**	0.319**	0.953**
SY	-0.214*	-0.264*	0.382**	0.013^{NS}	0.080^{NS}	0.303**	0.412**	0.298**	0.194^{NS}	0.993**	1	0.981**	0.480**	0.248*	0.300**	0.168^{NS}	-0.304**	0.328**	0.951**
DFY	-0.186^{NS}	-0.240*	0.378**	0.019^{NS}	0.106^{NS}	0.305**	0.419**	0.306**	0.156^{NS}	0.984**	0.981**	1	0.504**	0.273**	0.311**	0.154^{NS}	-0.288**	0.347**	0.974**
GY	-0.467**	-0.470**	0.366**	-0.013^{NS}	0.061^{NS}	0.107^{NS}	0.529**	0.326**	0.072^{NS}	0.502**	0.480**	0.504**	1	0.331**	0.453**	0.029^{NS}	-0.304**	0.218*	0.502**
PL	0.107^{NS}	0.120^{NS}	0.357**	-0.112^{NS}	-0.047^{NS}	0.078^{NS}	0.065^{NS}	0.249*	-0.097^{NS}	0.271**	0.248*	0.273**	0.331**	1	0.232*	0.025^{NS}	-0.247*	0.017^{NS}	0.251*
GW	-0.244*	-0.261*	0.020^{NS}	-0.024^{NS}	-0.053^{NS}	0.180^{NS}	0.416**	0.274**	-0.043^{NS}	0.304**	0.300**	0.311**	0.453**	0.232*	1	0.224*	-0.259*	0.253*	0.331**
TSS	0.035^{NS}	-0.007^{NS}	-0.090^{NS}	0.061^{NS}	0.007^{NS}	0.237*	0.248*	-0.073^{NS}	-0.055^{NS}	0.142^{NS}	0.168^{NS}	0.154^{NS}	0.029^{NS}	0.025^{NS}	0.224*	1	-0.055^{NS}	0.295**	0.207^{NS}
HCN	0.234*	0.157^{NS}	-0.050^{NS}	-0.224*	-0.190^{NS}	-0.025^{NS}	-0.169^{NS}	-0.238*	-0.029^{NS}	-0.292**	-0.304**	-0.288**	-0.304**	-0.247*	-0.259*	-0.055^{NS}	1	-0.066^{NS}	-0.273**
CP	-0.052^{NS}	-0.145^{NS}	0.016^{NS}	0.001^{NS}	0.018^{NS}	0.468**	0.334**	0.120^{NS}	0.003^{NS}	0.319**	0.328**	0.347**	0.218*	0.017^{NS}	0.253*	0.295**	-0.066^{NS}	1	0.544**
CPY	-0.172^{NS}	-0.243*	0.339**	0.016^{NS}	0.100^{NS}	0.380**	0.448**	0.313**	0.132^{NS}	0.953**	0.951**	0.974**	0.502**	0.251*	0.331**	0.207^{NS}	-0.273**	0.544**	1

*and** significance at 5 and1 percent level respectively.

TABLE 4
Direct (diagonal) and indirect (diagonal) path coefficient on dry fodder yield in sorghum

	DF	DM	PH	NT/P	NL/P	LL	LB	SD	L/S	GFY	SY	GY	PL	GW	TSS	HCN	CP	CPY
DF	**-0.204**	0.1253	0.6697	-0.5447	0.3299	0.2544	-0.4105	-0.4315	0.1688	0.3699	0.5835	0.6094	-0.8712	0.0056	0.3115	0.03	-0.007	-0.1239
DM	-0.1995	**0.1278**	0.6682	-0.5524	0.3134	0.2455	-0.3971	-0.42	0.165	0.3596	0.5755	0.6003	-0.8496	0.0054	0.301	0.03	-0.007	-0.122
PH	-0.1951	0.1223	**0.6983**	-0.5762	0.3312	0.2568	-0.4176	-0.4393	0.1704	0.3758	0.5921	0.6134	-0.8725	0.0057	0.3296	0.032	-0.007	-0.13
NT/P	-0.1869	0.119	0.6783	**-0.593**	0.3241	0.252	-0.3986	-0.4302	0.1671	0.3908	0.6052	0.6157	-0.8631	0.0055	0.3318	0.032	-0.007	-0.1297
NL/P	-0.1881	0.1122	0.648	-0.5385	**0.357**	0.2668	-0.4226	-0.4386	0.1732	0.3893	0.5969	0.6364	-0.912	0.0058	0.3461	0.032	-0.008	-0.1278
LL	-0.1844	0.1118	0.6389	-0.5325	0.3392	**0.281**	-0.4298	-0.4461	0.1644	0.3828	0.6139	0.6378	-0.9009	0.0059	0.3467	0.032	-0.007	-0.1268
LB	-0.19	0.1154	0.6633	-0.5377	0.3431	0.2744	**-0.44**	-0.457	0.1722	0.3782	0.6032	0.6355	-0.9031	0.0059	0.341	0.032	-0.007	-0.13
SD	-0.1885	0.1152	0.6586	-0.5479	0.3361	0.2688	-0.4313	**-0.466**	0.1756	0.3895	0.6146	0.6384	-0.8994	0.0058	0.3332	0.032	-0.007	-0.1309
L/S	-0.1896	0.1164	0.6573	-0.5473	0.3414	0.2549	-0.4179	-0.4516	**0.181**	0.3899	0.5976	0.6362	-0.8948	0.0057	0.3245	0.031	-0.007	-0.1289
GFY	-0.1807	0.1103	0.63	-0.5564	0.3336	0.258	-0.3992	-0.4355	0.1695	**0.4165**	0.6293	0.6342	-0.8941	0.0056	0.3386	0.032	-0.008	-0.1299
SY	-0.1815	0.1124	0.6319	-0.5486	0.3256	0.2634	-0.4053	-0.4375	0.1654	0.4006	**0.6543**	0.6599	-0.9084	0.0055	0.3318	0.031	-0.007	-0.1254
GY	-0.1692	0.1047	0.5844	-0.4982	0.3099	0.2442	-0.3811	-0.4057	0.1572	0.3604	0.5891	**0.733**	-1.008	0.0063	0.3549	0.033	-0.008	-0.1308
PL	-0.1732	0.1061	0.5952	-0.5001	0.318	0.247	-0.3878	-0.4053	0.1583	0.3638	0.5806	0.7217	**-1.024**	0.0064	0.3583	0.033	-0.008	-0.1326
GW	-0.1686	0.1025	0.5949	-0.4877	0.3107	0.2448	-0.3884	-0.4012	0.1537	0.3467	0.5328	0.6832	-0.9769	**0.007**	0.3711	0.034	-0.008	-0.138
TSS	-0.1636	0.0993	0.5942	-0.5081	0.319	0.2513	-0.387	-0.4006	0.1517	0.3641	0.5605	0.6715	-0.9468	0.0064	**0.387**	0.035	-0.008	-0.1364
HCN	-0.1736	0.1078	0.622	-0.5324	0.3227	0.2566	-0.3993	-0.4197	0.1602	0.3775	0.5753	0.677	-0.9581	0.0065	0.3774	**0.04**	-0.008	-0.1411
CP	-0.169	0.1046	0.6066	-0.5326	0.3228	0.2453	-0.3829	-0.4076	0.1605	0.3838	0.5809	0.6852	-0.9646	0.0063	0.3738	0.035	**-0.008**	-0.1393
CPY	-0.1741	0.1076	0.6264	-0.531	0.3149	0.2456	-0.3944	-0.4207	0.1611	0.3736	0.5664	0.6616	-0.9371	0.0064	0.3646	0.034	-0.008	**-0.145**

These results indicated the importance of various traits in the development of selection indices for higher dry fodder yield. The present study also suggested that development of good quality forage sorghum with lower HCN content is the complex target due to its negative correlation with economically important traits like green fodder yield, dry fodder yield, stover yield and other attributing traits. Damor *et al.* 2018, Soujanya et al. 2018 and Vijaylaxmi *et al.,* 2019 also reported that number of leaves per plant, plant height, days to 50% flowering, dry matter yield, crude protein content, leaf width, leaf length and number of tillers per plant showed positively significantly correlation with green fodder yield and HCN content showed negatively significant correlation with green fodder yield. Vijaylaxmi *et al.,* 2019 observed same results.

Hence based on inter correlation study among the green fodder yield, dry fodder yield and nutritional quality reveals some undesirable correlation between these traits which might become hurdle in achieving the major breeding objectives in forage sorghum. In path coefficient analysis, green fodder yield, grain yield, stover yield, plant height, TSS content had high positive direct effect on dry fodder yield. However, traits like panicle length, no. of tillers/plant, leaf breadth and stem diameter had negative direct effect on DFY. This indicates that if we want to develop dual type in sorghum increase in grain yield and green fodder yield quality traits like total soluble solids in stem also enhances.

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