Original Revised Research Article

Study of correlation and path coefficient analysis for different morphological characters in forage sorghum (*Sorghum bicolor* L. Moench)

Abstract

This research was conducted to investigate the correlation and path coefficient analysis of thirty three genotypes for green fodder yield ant its attributes of forage sorghum.The experimental material was planted in Completely Randomized Block Design (RBD)in three replicationduring *Kharif* in the year 2019-20 at Crop Research Centre, SVPUA&T, Modipuram, Meerut - 250110 (U.P.).The study of association and path analysis evaluation carried out using the ten green fodder yield traits, *viz*., days to 50% flowering, plant height, leaf length, leaf breadth, leaf area, stem girth, leaves per plant, leaf stem ratio, total soluble solids and green fodder yield per plant. There is significant and positive correlation with green fodder yield per plant was exhibited with stem girth, leaves per plant, leaf length, leaf breadth, leaf stem ratio and total soluble solids at genotypic and phenotypic level. While leaf area showed the maximal direct effect on green fodder yield per plant followed by stem girth, leaves per plant and leaf stem ratio. There for selection for these traits is advisable for improving the character of green fodder yield.

Key word: Genetic variability, Correlation, Path Coefficient, Quantitative traits

Introduction

"Sorghum **(*Sorghum bicolor* L. Moench)** is first important fodder crop, forasmuch of this has highly adaptation for the different ecological conditions, it has the wide range of resistant to drought and also suitable for low inputs requirement for cultivation"**(Doggett, 1988)**. "Sorghum is a C4 plant has the higher photosynthesis efficiency with more abiotic stress tolerance"**(Nagy *et al.*, 1995; Reddy et al., 2009)**. "Mostly five races *viz., Bicolor, Guinea, Caudatum, Durra and Kafir*are found as cultivated sorghum and ten races are intermediate which corresponding to the pair wise combination of major races. All ten races are recognize by the phenotypic characteristics, specifically inflorescence related traits" **(Harlan and de Wet, 1972)**. "Sorghum is the fifth most important food crop globally after Rice, Wheat, Maize and Pearlmillet and is animal dietary staple feed of nearly 500 million people in 30 countries. This is growing area in India is nearly 5.14 million hectares while its annual production is 4.57 million tonnes and productivity is 889kg ha^{-1}. In India its major producer states are Maharashtra, Karnataka, Madhay Pradesh, Andhra Pradesh, Rajasthan and Gujarat”**(Anonymous,2018)**.

“The sorghum is majorly used for the purpose of food, feed, and forage crop. Alongside ofsorghum also bestow the raw materials for the production of starch, fiber, dextrose syrup bio fuels, vinegar, alcohol and more products”.(**Karadi and Kajjidoni 2019**).

To develop sorghum as a viable and profitable crop, there is an incontinently need to begin research to develop varieties and hybrids with high grain and fodder yields, fast growth, early to medium maturity and good quality parameters. Improving grain and fodder yield potential in sorghum is a major concern for breeders. It has been observed that cultivated sorghum is more variable and suggests that, to increase yield, it is first necessary to know the nature and extent of genes present in the germplasm collection is a backbone. Estimating of genetic variability in the base population is the first step in any breeding program. It is necessary to study the relationships between traits to evaluate the feasibility of joint selection for two or more traits.The path coefficient is just a standard partial regression coefficient that measures the direct effect of one variable on another variable and allows the correlation coefficient to be separated into components of direct and indirect effects of different characteristics on the dependent variable, thus making effective selection. To understand the effect of green fodder yield, significant genotypic correlations of various attributes with green fodder yield per plant were divided into their direct and indirect effects. This will provide more detailed information to select key conditions that can contribute more to green fodder yield. The genetic variability is the important phenomena for ecological balance and this study aims to assessment the present variation in outcomes between selected genotypes.

Material and methods

This experimental material consisting of 33 advanced lines (Table-1) was grown in three replicates in a Randomized Blocked Design (RBD). The experimental material was planted in fields under irrigated conditions at the Crop Research Centre, Modipuram, SVPUA&T, Meerut - 250110 (U.P.) during the *Kharif* season 2019-20.All recommended agronomic practices were followed to produce a good sorghum crop with 4 rows of 5 meters long. The rowing space was 30 cm and the planting space was to be planted at 10 cm respectively. Observations were recorded on yield and yield attributing characters *viz.,*days to 50% flowering (day), plant height (cm), leaf length (cm), leaf breadth (cm), leaf area $(cm)^2$, stem girth (mm), leaves per plant, leaf stem ratio, total soluble solids (% by refractometer reading), green fodder yield (g/plant). Flowering day was recorded as the number of days after sowing, 50 percent of plants in each plot flowered while leaf area $(cm)^2$ = leaf length (cm) x leaf breadth x 0.71 and leaf stem ratio calculated using the formula, Leaf stem ratio = Fresh weight of all the leaves/Fresh weight of stems. All the observations were taken from each plot, on randomly five selected plants from each genotype. The correlations at genotypic, phenotypic and environmental levels were calculated from the analysis of variance and covariance as suggested by **Searle (1961)**whilepath coefficient analysis was performed according to the method suggested by **Dewey and Lu (1959**).

Table 1: List of forage sorghum genotypes:

Sl. No.	Genotype	Sl. No.	Genotype	Sl. No.	Genotype
1.	HC-541	**12.**	Pant Chari-3	**23.**	CSV-14
2.	Pant Chari-8	**13.**	Pant Chari-5	**24.**	CSV-13
3.	Pusa Chari-6	**14.**	HC-573	**25.**	Bundela Chari
4.	HC-171	**15.**	HC-308	**26.**	HJ-513
5.	HC-136	**16.**	Pusa Chari-9	**27.**	CSV-12
6.	Pratap Raj Jowar-1	**17.**	Pant Chari-4	**28.**	HC-260
7.	MP Chari	**18.**	SSG59-3	**29.**	CSV-28
8.	HJ-541	**19.**	Pusa Chari-23	**30.**	CSV-20
9.	Pusa Chari-615	**20.**	Versha	**31.**	PJ-1430
10.	Pant Chari-6	**21.**	CSV-15	**32.**	CSV-27
11.	Pant Chari-2	**22.**	Pant Chari-7	**33.**	CSV-23

Result and discussion

Correlation coefficients are estimated between the yield and its contributed characteristics at the genotypic and phenotypic levels. Correlations at the genotypic level are higher than their corresponding phenotypic correlations. The results of genotypic and phenotypic correlation coefficients between the crop and its components are given in (Table 2). In most cases the direction and magnitude of genotypic and phenotypic correlations between different traits remained nearly identical.

In this study, green fodder yield is estimated as significant and positive correlation was exhibited with stem girth (0.68), leaves per plant (0.67), leaf length (0.64), leaf breadth (0.47), leaf stem ratio (0.27) and total soluble solids (0.20) at genotypic level grain yield per plant was found to be significantly and positively correlated withgreen fodder yield per plant was exhibited with stem girth (0.68), leaves per plant (0.67), leaf length (0.64), leaf breadth (0.47), leaf stem ratio (0.27) and total soluble solids (0.20) at genotypic level.While green fodder yield per plant showed negative significant relationship with days to 50% flowering (-0.25), green fodder yield per plant with plant height (-0.12) and leaf area (-0.19) A negative however no significant correlation is shown at the genotypic level.Hence, enhancement of green fodder yield can be achieved by improving these characters in forage sorghum. This result are ingenerally revealed with the finding of **Dubey *et al.* (2016)** recorded the leaf area, leaf length, number of leaves, grain weight showed significant positive correlation with yield per plant**. Jain *et al.* (2017)** recorded plant height, stem girth and leaf length were positively and significantly associated with green fodder and dry fodder yield per plant. **Prasad and Sridhar (2020)** exhibited positive significant association green fodder yield with days to 50% flowering, days to maturity, number of leaves per plant, leaf length, leaf breadth, stem ratio and yield per plant.While **Rohila *et al.* (2020)**recorded negatively associated the time of panicle emergence with green fodder yield.

The division of path coefficients into direct and indirect effects was done based on the results at the phenotypic level (Table 3). Critical observation of the results in the table revealed that leaf area (0.64) showed the maximum order of direct effect on green fodder yield, followed by stem girth (0.51), leaves per plant (0.49) and leaf stem ratio (0.17) was observed.The identical resultreported by **Damor *et al.* (2018)** where a positive direct effect on grain yield for green fodder yield at both genotypic and phenotypic levels and **Prasad and Sridhar (2020)** recorded positive direct effect on grain yield for fodder yield at both genotypic and phenotypic level and **Prasad and Sridhar (2020)** found the plant height exhibited positive direct effect with yield per plant. While maximum negative direct effect was shown for plant height (-0.14), leaf length (-0.15) and leaf breadth (-0.19). Direct and indirect effects also recorded at the phenotypic level were generally similar to those shown at the genotypic level with little variation in magnitude. Levels of residual effects were low at the phenotypic and genotypic levels, indicating that the characters included in the present investigation were sufficient enough to account for the variability in the dependent attribute *i.e.* green fodder yield. The direct contribution of leaf area, stem girth, leaves per plant and leaf stem ratio with green fodderyield per plant observed in this study is also in confirmation with the findings **Malaghan and Kajjidoni (2019)**.

Table-2: Estimates of correlation coefficients for genotypic (G) and phenotypic (P) levels among different characters in forage sorghum (*Sorghum bicolor* L. Moench)

Characters		Days to 50% flowering	Plant Height (cm)	Leaf length (cm)	Leaf breadth (cm)	Leaf area (cm^2)	Stem girth (mm)	Leaves per plant	Leaf stem ratio	Total soluble solids (%)	Green fodder yield per plant (g)
Days to 50% flowering	G	1.00	0.12	0.11	0.30**	0.25**	0.25**	-0.02	-0.02	0.36**	-0.25**
	P	1.00	0.15	0.12	0.26**	0.22**	0.22**	-0.02	-0.02	0.31**	-0.23**
Plant Height (cm)	G		1.00	0.23**	0.33**	0.41**	-0.11	0.21*	0.20*	-0.33**	-0.12
	P		1.00	0.22**	0.39**	0.42**	-0.11	0.20*	0.20*	-0.33**	-0.12
Leaf length (cm)	G			1.00	-0.09	0.40**	0.23*	0.14	0.33**	0.30**	0.64**
	P			1.00	-0.09	0.39**	0.23*	0.13	0.32**	0.30**	0.65**
Leaf breadth (cm)	G				1.00	0.94**	0.23*	0.31**	-0.03	-0.10	0.47**
	P				1.00	0.94**	0.23*	0.29**	-0.03	-0.10	0.49**
Leaf area (cm^2)	G					1.00	0.14	0.34**	-0.01	-0.13	-0.19
	P					1.00	0.18	0.39**	-0.02	-0.13	-0.19
Stem girth (mm)	G						1.00	-0.06	0.51**	0.12	0.68**
	P						1.00	-0.06	0.50**	0.12	0.69**
Leaves per plant	G							1.00	0.21	-0.10	0.67**
	P							1.00	0.16	-0.10	0.69**
Leaf stem ratio	G								1.00	0.45**	0.27**
	P								1.00	0.44**	0.27**
Total soluble solids (%)	G									1.00	0.20*
	P									1.00	0.20*
Green fodder yield per plant (g)	G										1.00
	P										1.00

*, ** significant at 5% and 1% level respectively.

Table-3: Path coefficient analysis showing the direct and indirect effect of ten characters on the green fodder yield at genotypic and phenotypic levels of forage sorghum (*Sorghum bicolor* L. Moench)

Characters		Days to 50% flowering	Plant Height (cm)	Leaf length (cm)	Leaf breadth (cm)	Leaf area (cm^2)	Stem girth (mm)	Leaves per plant	Leaf stem ratio	Total soluble solids (%)
Days to 50% flowering	G	**0.10**	-0.02	-0.01	-0.04	0.05	-0.13	-0.21	-0.06	0.01
	P	**0.03**	-0.01	-0.01	-0.05	0.05	-0.11	-0.14	-0.02	0.02
Plant Height (cm)	G	0.01	**-0.15**	-0.03	-0.05	0.08	0.06	-0.07	0.04	0.01
	P	0.04	**-0.14**	-0.03	-0.06	0.10	0.06	-0.05	0.03	0.03
Leaf length (cm)	G	0.01	0.23	**-0.13**	-0.02	0.08	0.04	-0.04	0.07	-0.02
	P	0.05	0.33	**-0.15**	-0.02	0.09	0.04	-0.03	0.08	-0.02
Leaf breadth (cm)	G	0.03	0.25	-0.02	**-0.15**	0.19	-0.12	-0.10	-0.08	0.02
	P	0.09	0.24	-0.02	**-0.19**	0.23	-0.12	-0.08	-0.09	-0.02
Leaf area (cm^2)	G	0.02	-0.06	-0.05	-0.14	**0.62**	-0.07	-0.09	0.07	-0.24
	P	0.07	-0.05	-0.06	-0.18	**0.64**	-0.07	-0.07	0.06	-0.24

Stem girth (mm)	G	0.02	0.21	0.01	-0.03	0.02	**0.50**	-0.11	-0.06	-0.04
	P	0.04	0.24	0.01	-0.04	0.03	**0.51**	-0.08	-0.05	-0.09
Leaves per plant	G	0.06	0.04	-0.02	-0.04	0.05	-017	**0.44**	0.02	0.03
	P	0.07	0.06	-0.02	-0.05	0.06	-0.16	**0.49**	0.01	0.07
Leaf stem ratio	G	-0.03	0.34	-0.04	0.06	0.06	0.15	-0.03	**0.21**	0.01
	P	-0.01	0.36	-0.05	0.07	0.08	0.15	-0.02	**0.17**	0.03
Total soluble solids (%)	G	0.03	0.02	-0.04	0.02	-0.02	0.05	-0.02	-0.02	**-0.03**
	P	0.05	0.02	-0.04	0.02	-0.03	0.05	-0.02	-0.01	**-0.08**

Residual values (G) = 0.17 Residual values (P) = 0.28*, ** significant at 5%, 1% level, respectivelyBold values indicate direct effects

CONCLUSION

Green fodder yield per plant had highly significant positive correlations with leaf length, leaf breadth, stem girth, leaves per plant, leaf stem ratio and total soluble solids at genotypic and phenotypic levels. Therefore, green forage productivity can be increased by improving these characteristics in forage sorghum.

The genotypic and phenotypic path coefficient analysis of green fodder yield per plant and its component attributes showed that leaf area had the extremely positive direct on green fodder yield per plant followed by stem girth, leaves per plant and leaf stem ratio, indicates that these traits could be considered as most important characters for improving fodder yield.

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