Current Journal of Applied Science and Technology

Volume 42, Issue 34, Page 32-36, 2023; Article no.CJAST.105520
ISSN: 2457-1024
(Past name: British Journal of Applied Science & Technology, Past ISSN: 2231-0843, NLM ID: 101664541)

Correlation and Path Analysis of Sorghum [*Sorghum bicolor* (L.) Moench]

N. Sihag [a*], P. K. Shrotria [a] and P. K. Pandey [a]

[a] Department of Genetics and Plant Breeding, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar-263145, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors have contributed equally. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/CJAST/2023/v42i344231

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/105520

Original Research Article

Received: 15/07/2023
Accepted: 18/09/2023
Published: 05/10/2023

ABSTRACT

During Kharif 2017, 96 sorghum accessions were tested and characterised for several yield component characteristics and morphological factors at the Govind Ballabh Pant University of Agriculture and Technology's Instructional Dairy Farm in Pantnagar, Uttarakhand, India. A positive and significant correlation coefficient of component traits ensures their potential for selection in order to maximize fodder yield. In the present study green fodder yield and dry fodder yield were found to be significantly and positively associated with plant height (0.389, 0.351) and stem girth (0.476, 0.418). leaf length (0.011), stem girth (0.007), leaf width (0.001) and plant height (0.002) were observed to have a positive direct effect on green fodder yield. The findings of the research reveal noteworthy relationships between green fodder yield, dry fodder yield and specific morphological attributes. Therefore, these characters provide enormous opportunity for selection to improve yield. The present study has implications in current breeding programmes for developing improved varieties by highlighting the specific traits and parameters that can contribute significantly to higher fodder yield, breeders can strategically target these characteristics during the selection

**Corresponding author: E-mail: nivsihag310@gmail.com;*

and breeding process. By identifying features that have a direct beneficial influence on yield, the study gives practical insights that can benefit fodder production and as a result, the livestock and agriculture industries.

Keywords: Correlation; path analysis; germplasm; evaluation; fodder yield; morphological traits.

1. INTRODUCTION

"Sorghum (*Sorghum bicolor* (L.) Moench) is a diploid plant with 2n = 20 somatic chromosomes that belongs to the Poaceae family" [1]. It is thought to have originated in Northeastern Africa between 5000 and 8000 years ago [2,3]. The Indian Subcontinent is the secondary origin of sorghum, with evidence of early grain production extending back roughly 4500 years [4]. "Sorghum is adapted to a broad range of environmental conditions from the highlands of Ethiopia to the semi-arid Sahel. Tribal group has distributed the five different races of sorghum (Bicolor, Caudatum, Durra, Guinea, and Kafir) to wide range of places due to their movement in Africa [5,6]. Sorghum is the fifth most important grain crop, providing fodder and food all over the world" [7]. "Sorghum is a staple diet for millions of poor rural people in Asia and Africa's semiarid tropics" [6].

Sorghum grain is rich in protein (11.3%), fat (3.3%), iron, zinc, phosphorus and B-complex vitamins. Red-grained sorghum is rich in tannins (antioxidants) that protects against cell damage [8,9,10]. "Forage sorghum can be used to make silage, hay and pasture for animal feed. The demand for fodder sorghum is expanding rapidly. To fulfil demand, there must be an increase in output, which should come from it or from a smaller area given the current scenario of dwindling agricultural land" [11]. "The creation of a broad genetic basis, stable, and high-yielding sorghum cultivars need a continuous supply of new germplasm as a source of favourable genes in breeding operations. The diverse germplasm is a fantastic resource for enhancing plant adaptation and other agronomic characteristics" [12].

"Because of its endurance to heat and drought stress, it is suited to a larger variety of ecological circumstances for other crops, including low soil moisture, hot and dry temperatures" [13,14]. It is referred to as a high-energy crop due to its excellent water usage efficiency and solar energy conversion. It is produced mostly for fodder and food. Sorghum grain is a staple diet in Africa, Asia, and other low-income countries, as well as a fodder and feed crop for cattle [9]. The primary goal of any plant breeding effort is to find and select superior genotypes with desirable features from a wide variety of breeding material by properly using the crop's available diversity. Correlation coefficients can be used to investigate the mutual relationship between different characters in order to develop appropriate selection criteria, whereas path coefficient analysis can be used to determine the direct and indirect causes of association between the dependent and independent variables. To begin an effective selection programme, both correlation and route analysis are necessary to analyze the relationship of numerous component characteristics and their direct and indirect impacts on yield contributing characters.

2. MATERIALS AND METHODS

During Kharif 2017, the current study was carried out at the Govind Ballabh Pant University of Agriculture and Technology's Instructional Dairy Farm in Pantnagar, Uttarakhand, India. "In an Augmented Block Design, 96 germplasm accessions were planted in two rows of three meters length with 45cm row spacing. For cultivation, the recommended package of practices were followed. Data was recorded on time to 50% flowering (days), plant height (cm), stem girth (cm), number of nodes per plant, panicle width(cm), leaf width (cm), leaf length (cm), flag leaf length(cm), flag leaf width(cm), 1000 grain weight per panicle(gm), panicle length (cm), HCN content (ppm), days to maturity, dry matter %, Brix%, protein content (%),dry fodder yield(g/plant) and green fodder yield (g/plant).Correlation coefficient and phenotypic path analysis was statistically estimated" [15,16].

3. RESULTS AND DISCUSSION

Correlation between yield component characters and estimates of direct and indirect effects of component characters on yield can be useful in predicting the correlated response to directional selection as well as identifying some characters that may not have value in themselves but are useful indices to consider in yield improvement.

Green fodder yield correlated positively with plant height, stem girth, number of nodes, flag leaf width, flag leaf length, and dry fodder yield (Table 1). As a result, these characteristics offer an incredible amount of potential for selection to boost green fodder output. The current study found a positive and substantial relationship between plant height and green fodder output per plant, and other studies found comparable findings [17,18,19,20 and 21]. The yield of green fodder was shown to be strongly and positively related to leaf length, plant height, stem thickness, and dry matter content [22]. Plant height and stem girth were shown to have a strong and favourable relationship with green forage output [21 and 5]. Plant height and stem girth were shown to have a highly substantial and positive association with dry fodder output per plant [23 and 6]. Leaf length and dry matter content were also shown to be strongly and positively linked with green fodder yield [24]. Plant height, on the other hand, was shown to be positively linked with panicle length and panicle breadth [25]. The number of leaves and green fodder output of fodder cowpea were shown to be positively related [26]. Path analysis is used to determine the directed relationships between variables. The efficiency of a character for direct selection is revealed by phenotypic path analysis when it has a positive and high direct influence on green fodder yield. In a breeding programme, a character with a high direct influence and positive and high indirect effects through other characteristics gives the ideal conditions for selection. In the current study, stem girth (cm), plant height (cm), number of nodes, leaf length (cm), leaf breadth (cm), and flag leaf length (cm) are the features that may be employed in selection programmes to increase fodder output. During the research, a positive direct influence of stem girth on green fodder output was discovered (Table 2), and comparable results were reported in other experiments [11,27 and 28]. Leaf breadth was discovered to have a direct favourable influence on green forage output [22]. Green fodder output was shown to be positively affected by leaf length, plant height, and stem girth [20]. The residual impact associated with a standard partial regression value of 0.0133 suggests that the remaining components other than those analyzed have a very minor contribution.

Table 1. The coefficient of correlation between nineteen sorghum genotype characters

Correlation Coefficient Analysis: Min. | 0 | Max.

	Days to 50% flowering	Plant height (cm)	Stem girth (cm)	Number of nodes	Leaf length (cm)	Leaf width (cm)	Flag leaf length (cm)	Flag leaf width (cm)	Panicle length (cm)	Panicle width (cm)	Days to maturity	HCN (ppm)	Protein content%	Brix %	IVDMD	Dry matter %	1000 seed weight (g)	Dry fodder yield (g/plant)	Green fodder yield (g/plant)
Days to 50% flowering	1																		
Plant height (cm)	0.132	1																	
Stem girth (cm)	0.019	0.267	1																
Number of nodes	0.341	0.571	0.407	1															
Leaf length (cm)	-0.029	0.347	0.258	0.34	1														
Leaf width (cm)	0.02	0.209	0.393	0.266	0.014	1													
Flag leaf length (cm)	0.142	0.357	0.33	0.177	0.163	0.164	1												
Flag leaf width (cm)	0.171	0.242	0.486	0.189	0.165	0.445	0.636	1											
Panicle length (cm)	-0.145	0.415	-0.016	0.149	0.164	0.062	0.043	-0.148	1										
Panicle width (cm)	-0.018	0.397	0.302	0.363	0.087	0.306	0.087	0.09	0.471	1									
Days to maturity	0.73	0.11	0.008	0.325	-0.059	-0.026	0.164	0.144	-0.043	0.038	1								
HCN (ppm)	0.06	0.032	0.089	0.206	0.179	0.09	-0.096	-0.036	-0.038	0.057	0.152	1							
Protein content%	-0.003	-0.059	0.075	-0.046	0	0.044	-0.036	0.026	-0.077	0.08	-0.116	-0.006	1						
Brix %	0.042	0.103	-0.056	0.014	0.15	-0.027	0.093	0.175	0.074	0.1	0.028	0.239	-0.043	1					
IVDMD	-0.047	-0.13	-0.076	-0.096	0.088	0.098	0.064	0.127	0.095	0.006	-0.087	0.007	0.03	0.273	1				
Dry matter %	-0.463	0.001	-0.006	-0.188	0.042	0.019	-0.111	-0.166	0.194	0.148	-0.318	-0.054	0.198	-0.065	-0.021	1			
1000 seed weight (g)	0.113	0.066	0.187	0.218	0.286	0.215	0.014	0.114	0.098	0.083	0.027	0.215	-0.037	0.326	0.055	-0.077	1		
Dry fodder yield (g/plant)	-0.093	0.351	0.418	0.184	0.149	0.263	0.252	0.2	0.149	0.17	-0.101	0.159	0.039	0.207	0.08	0.468	0.133	1	
Green fodder yield (g/plant)	0.144	0.389	0.476	0.288	0.134	0.291	0.376	0.333	0.067	0.115	0.045	0.188	-0.048	0.259	0.126	0.009	0.171	0.88	1

Table 2. The study of phenotypic path coefficients reveals the direct and indirect effects of 18 characters on green fodder yield

Path coefficient analysis: Min. | | 0 | | Max.

	Correlation with yield	Direct effect	Days to 50% flowering	Plant height (cm)	Stem girth (cm)	Number of nodes	Leaf length (cm)	Leaf width (cm)	Flag leaf length (cm)	Flag leaf width (cm)	Panicle length (cm)	Panicle width (cm)	Days to maturity	HCN (ppm)	Protein content%	Brix %	IVDMD	Dry matter %	1000 seed weight (g).	Dry fodder yield (g/plant)
Days to 50 % flowering	0.144	0.041		-0.002	0.001	-0.005	0.001	0.001	0.006	-0.003	-0.001	-0.001	-0.023	0.001	-0.001	-0.001	-0.001	0.231	-0.001	-0.102
Plant height (cm)	0.389	0.002	0.005		0.002	-0.009	-0.003	0.003	0.016	-0.005	0.001	0.002	-0.003	0.001	-0.001	-0.001	-0.003	-0.003	-0.001	0.387
Stem girth (cm)	0.476	0.007	0.001	-0.001		-0.006	-0.002	0.003	0.014	-0.001	-0.001	0.001	-0.001	0.001	0.002	0.004	-0.002	0.003	-0.002	0.462
Number of nodes	0.288	0.015	0.014	-0.001	0.003		-0.003	0.004	0.007	-0.004	0.004	0.001	-0.01	0.003	-0.001	-0.001	-0.002	0.093	-0.002	0.203
Leaf length (cm)	0.134	0.011	-0.001	-0.007	-0.001	-0.005		0.002	0.007	-0.003	0.004	0.004	0.001	0.003	0.001	-0.001	0.002	-0.02	-0.003	0.165
Leaf width (cm)	0.291	0.001	0.008	-0.004	0.002	-0.004	-0.001		0.007	-0.001	0.001	0.001	0.008	0.001	0.001	0.002	0.002	-0.009	-0.002	0.291
Flag leaf length (cm)	0.376	0.045	0.005	-0.007	0.002	-0.002	-0.001	0.002		-0.001	0.001	0.004	-0.005	-0.001	-0.001	-0.008	0.001	0.055	-0.001	0.278
Flag leaf width (cm)	0.333	-0.002	0.007	-0.005	0.003	-0.003	-0.001	0.007	0.028		-0.004	0.004	-0.004	-0.006	0.007	-0.001	0.003	0.083	-0.001	0.221
Panicle length (cm)	0.067	0.001	-0.005	-0.008	-0.001	-0.002	-0.001	0.001	0.001	0.003		0.002	0.001	-0.001	-0.002	-0.006	0.002	-0.096	0.001	0.165
Panicle width (cm)	0.115	0.005	-0.007	-0.008	0.002	-0.005	-0.009	0.004	0.003	-0.002	0.001		-0.001	0.001	0.002	-0.008	0.001	-0.073	-0.001	0.187
Days to maturity	0.045	-0.032	0.03	-0.002	0.001	-0.005	0.006	-0.001	0.007	-0.003	-0.001	0.002		0.002	-0.003	-0.002	-0.002	0.158	-0.003	-0.111
HCN (ppm)	0.188	0.001	0.002	-0.001	0.001	-0.003	-0.002	0.001	-0.004	0.001	-0.001	0.003	-0.004		-0.001	-0.002	0.001	0.026	-0.002	0.175
Protein content %	-0.048	-0.002	-0.001	0.001	0.005	0.007	-0.001	0.001	-0.001	-0.001	-0.002	0.004	0.003	-0.001		0.003	0.007	-0.098	0.005	0.042
Brix %	0.259	-0.008	0.001	-0.002	-0.004	-0.002	-0.001	-0.001	0.004	-0.003	0.001	0.005	-0.009	0.004	-0.001		0.007	0.032	-0.004	0.229
IVDMD	0.126	0.026	-0.001	0.002	-0.005	0.001	-0.001	0.001	0.002	-0.002	0.001	0.001	0.002	0.001	0.001	-0.002		0.01	-0.007	0.087
Dry matter %	0.009	-0.499	-0.019	-0.001	-0.001	0.002	-0.004	0.001	-0.005	0.003	0.005	0.007	0.01	-0.001	0.005	0.005	-0.005		0.001	0.517
1000 seed weight (g)	0.171	-0.013	0.004	-0.001	0.001	-0.003	-0.003	0.003	0.006	-0.002	-0.001	0.001	-0.008	0.003	-0.001	-0.002	0.001	0.038		0.147
Dry fodder yield (g/plant)	0.88	0.105	-0.003	-0.007	0.003	-0.002	-0.001	0.004	0.011	-0.004	0.001	0.009	0.003	0.002	0.001	-0.001	0.002	-0.233	-0.001	

Residual factor = 0.013

4. CONCLUSION

Green fodder yield correlated positively with plant height, stem girth, number of nodes, flag leaf width, flag leaf length, and dry fodder yield. As a result, these characteristics offer an incredible amount of potential for selection to boost green fodder output. In the current study, stem girth (cm), plant height (cm), number of nodes, leaf length (cm), leaf breadth (cm), and flag leaf length (cm) are the features that may be employed in selection programmes to increase fodder output.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Spangler R, Zaitchik B, Russo E, Kellogg E. Andropogoneae Evolution and generic limits in sorghum (Poaceae) using ndhF sequences. Syst Bot. 1999;24(2):267-81. DOI: 10.2307/2419552
2. De Candolle A. New York: Hafner Publishing Company; 1884. Origin of Cultivated Plants.
3. Jean P. USDA crop summary. Sorghum production; 2008. Available:www.nda.agric.za/Publication
4. Mutegi E, Sagnard F, Muraya M, Kanyenji B, Rono B, Mwongera C, et al. Eco-geographical distribution of wild weedy and cultivated *Sorghum bicolor* (L.) Moench in Kenya: implications for conservation and crop-to-wild gene flow. Genet Resour Crop Evol. 2010;57(2):243-53. DOI: 10.1007/s10722-009-9466-7
5. Keerthana K, Ganesan KN, Iyanar K, Sivakumar SD, Jeyakumar P. Gene action and contribution of different traits for enhanced green fodder yield and quality in pearl millet napier interspecific hybrids. Electron J Plant Breed. 2022;13(3):1066-76.
6. Rani R, Khandelwal V, Ramesh SJ, Singh A, Kumar V. Genetic variability and association analysis for dry fodder yield and its component traits in pearl millet inbred. Forage Res. 2022;48(1):57-61.
7. Doggett H. Sorghum. Longman Scientific, and London: Technical; 1988.
8. Salah M, Elsafi M, Nafisa E. Efficacy of Apron star 42WS on control of covered and loses head smuts in sorghum. In: Proceedings of the 70th meeting of the Pests and Diseases Committee p. 2004;64.
9. Proietti I, Frazzoli C, Mantovani A. Exploiting nutritional value of staple foods in the world's semi-arid areas: Risks, benefits, challenges and opportunities of sorghum. Healthcare (Basel). 2015;3(2): 172-93. DOI: 10.3390/healthcare3020172, PMID 27417755.

10. Khoddami A, Messina V, Vadabalija Venkata K, Farahnaky A, Blanchard CL, Roberts TH. Sorghum in foods: functionality and potential in innovative products. Crit Rev Food Sci Nutr. 2023; 63(9):1170-86.
DOI: 10.1080/10408398.2021.1960793, PMID 34357823.
11. Prakash R, Ganesamurthy K, Nirmalakumari K, Nagarajan P. Correlation and path analysis in sorghum [*Sorghum bicolor* (L.) Moench]. Electron J Plant Breed. 2010;1(3):315-8.
12. Huang Y. Evaluation of genetic diversity in sorghum germplasm using molecular markers. In: Poster CA, editor International Plant & Animal Genome XII Conference, San Diego. 2004;265.
13. Poehlman JM. Breeding sorghum and millet. In: Breeding field crops. Dordrecht: Springer. 1987;508-55.
14. Wagaw K. Review on mechanisms of drought tolerance in Sorghum (*Sorghum bicolor* (L.) Moench) basis and breeding methods. Acad Res J Agric Sci Res. 2019;7:87-99.
15. Searle SR. Phenotypic, genetic and environmental correlations. Biometrics. 1961;17(3):474-80.
DOI: 10.2307/2527838
16. Dewey DR, Lu KH. Correlation and path coefficient analysis of components of crested Wheat grass seed production. Agro. J. 1959;51:515-8.
17. Iyanar K, Vijaykumar G, Khan AKF. Correlation and path analysis in multicut fodder sorghum. Electr J Plant Breed. 2010;1(4):1006-9.
18. Jain SK, Patel PR. Variability, correlation and path analysis studies in sorghum (*Sorghum bicolor* L. Moench). Forage Res. 2013;39(1):27-30.
19. Khurd GN. Genetic diversity studies in Sudan grass; 2013 (Phule M Krishi Vidyapeeth [doctoral dissertation]. Rahuri.).
20. Singh G, Sohu R, Bhardwaj R, Rathore P. Variability and character association studies in multi-cut fodder sorghum. J Hill Agric. 2018;9(1):30-4.
DOI: 10.5958/2230-7338.2018.00005.8
21. Aswini MS, Ganesan KN, Ezhilarasi T, Sivakumar SD. Genetic studies on association and interrelationship of green fodder yield and fodder quality traits in hybrids of fodder pearl millet [*Pennisetum glaucum* (L.) R. Br.]. Int J Multidiscip Res Growth Eval. 2022;3(1):01-6.
22. Khurd GN, Kadam VK, Chavan BH, Dahat DV. Study on variability, correlation and path coefficient analysis in Sudan grass (*Sorghum sudanense* L.). IJCS. 2018;6(4):08-11.
23. Singh S, Yadav YP, Yadav HP, Vart D, Yadav N. Studies on genetic variability and traits association for grain yield and its components in pearl millet. Forage Res. 2014;40(2):91-4.
24. Kumar S, Babu C, Revathi S, Iyanar K. Estimation of genetic variability, heritability and association of green fodder yield with contributing traits in napier grass [*Pennisetum purpureum* Schum.]. VEGETOS An Int J Plant Res. 2017; 30(special):463-8.
DOI: 10.5958/2229-4473.2017.00119.7
25. Mofokeng MA, Shimelis H, Laing M, Shargie N. Genetic variability, heritability and genetic gain for quantitative traits in South African sorghum genotypes. Aust J Crop Sci. 2019;13(1):1-10.
DOI: 10.21475/ajcs.19.13.01.p718
26. Navaselvakkumaran T, Babu C, Sudhagar R, Sivakumar SD. Studies on interrelationship and path coefficient analysis of fodder yield and yield component traits in fodder cowpea (*Vigna ungiculata* L. Walp). Electron J Plant Breed. 2019;10(2):720-6.
DOI: 10.5958/0975-928X.2019.00093.0
27. Jain SK, Elangovan M, Patel NV. Correlation and path coefficient analysis for agronomical traits in forage sorghum [Sorghum bicolor (L.) Moench]. Indian J Plant Genet Resour. 2010;23(1):15.
28. Ramdevsinh RH. study of variability, correlation and path analysis in forage sorghum [*Sorghum bicolor* (L.) Moench] (Doctoral dissertation, AAU, Anand); 2012.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/105520