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STUDIES ON CHARACTER ASSOCIATION AND PATH ANALYSIS FOR GRAIN YIELD AND YIELD ATTRIBUTES IN *KHARIF* SORGHUM HYBRIDS (*SORGHUM BICOLOR* L. MOENCH)

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ABSTRACT

The present investigation was undertaken to assess correlation and path coefficient analysis among forty grain sorghum hybrids for grain yield per plant. The experiment was conducted in a Randomized Block Design at the AICRP on Sorghum, Chamarajanagar, during Kharif 2024. Correlation analysis revealed that grain yield per plant exhibited a significant positive association with ear head weight, ear head width, number of primaries per panicle, number of leaves, and leaf length, whereas days to maturity showed a negative correlation with grain yield. Path coefficient analysis indicated that ear head length and days to fifty per cent flowering exerted a significant positive direct effect on grain yield per plant, highlighting their importance in yield improvement.

Keywords : Correlation, Path-coefficient analysis, Sorghum hybrids.

Introduction

Sorghum [*Sorghum bicolor* (L.) Moench] has been classified under the family Poaceae, sub-family Panicoideae, tribe Andropogoneae and genus Sorghum, with diploid chromosome number $2n = 20$ with a genome size of 730 Mb (Paterson *et al.* 2004). It has a C_4 photosynthetic pathway, due to which there is an increase in the photosynthetic efficiency under intense light and high temperature. Sorghum has been said to have originated in Africa (Venkateswaran *et al.*, 2019). As it is an important millet crop, it ranks fifth in the world after wheat, rice, maize and barley. It is an important staple food for more than 300 million people and feed for cattle in Asia and Africa.

Knowledge of the relationship among yield components is essential for the formulation of breeding programme aimed at achieving the desired combinations of various components of yield. The estimates of correlation coefficients among the different characters indicate the extent and direction of association. The correlation coefficients provide a reliable measure of association among the characters and help to differentiate vital associations useful in

breeding from those of the non-vital ones (Falconer, 1981).

Correlation study serves as a fundamental tool in plant breeding, as it helps to understand the relationships (both favourable and unfavourable) among various traits, which can influence breeding decisions and the improvement of plant varieties. It assists in selecting the most beneficial traits that contribute to yield and vigour by analyzing how traits relate to each other. Breeders can make informed decisions that enhance multiple characteristics simultaneously, which is particularly important for complex traits like yield (Neyhart *et al.*, 2019). Moreover, correlational analysis can help in predicting the genetic gain achievable from selection, as correlated traits can affect the overall effectiveness of selection strategies. This predictive ability allows for better planning and resource allocation in breeding programs.

Path analysis study is vital in plant breeding as it aids in dissecting the total correlation between traits into respective direct and indirect effects, providing a clearer picture of how different traits influence each

other and contribute to yield (Khan *et al.*, 2022). This methodology helps breeders to identify specific traits that should be prioritized for selection in breeding programs. It also enables the evaluation of interactions among multiple traits, thereby clarifying how various characteristics work together to influence overall plant performance. It is very significant in complex traits, as it helps breeders manage traits that may not behave independently, allowing them to select for both direct and indirect effects. The precision of path analysis allows for a more accurate prediction of genetic gains from selection, making it an essential tool for breeders aiming for improvement in economically important traits such as yield and stress resistance. By focusing on traits that have substantial path coefficients, breeders can increase the success rate of their breeding efforts.

In essence, both correlation and path analysis provide a framework for understanding the multifaceted relationships among traits. This understanding is essential for making data-driven, strategic breeding decisions that aim to enhance crop performance, stability, and resilience in an ever-changing agricultural landscape. Hence, the present investigation was undertaken to elucidate insights into character association and the direct and indirect effects of yield components on grain yield by employing correlation coefficients and path coefficient analysis.

Material and Methods

The experimental material for the present study consisted of 40 hybrids of grain sorghum along with two checks (CSH-15 and CSH-30), evaluated at AICRP on Sorghum, ARS, Chamarajanagar, during the *kharif* season of 2024, with a planting arrangement of 45 cm × 15 cm. The experiment was structured using a Randomized Complete Block Design (RCBD) with two replications. Data were recorded from five robust plants within each genotype across two replications for traits such as days to fifty per cent flowering, plant height, number of leaves per plant, leaf length, days to maturity, stem diameter, ear head length, ear head width, number of primary branches per panicle, ear head weight, hundred-seed weight, and grain yield per plant. The mean values of these five randomly selected plants were subjected to correlation and path analyses using R Studio 4.4.2.

Results and Discussion

Genotypic correlation quantifies the proportion of variance shared by two genetic traits due to genetic causes. This type of correlation is significant for plant breeders as it helps in making efficient selections for desired characteristics within a population. Unlike

phenotypic correlations, genotypic correlations are based on transmissible genetic variances, making them particularly useful for breeding methods (Povilaitis, 1965). In plant breeding, genotypic correlations offer important information for planning breeding strategies, selection, and interpreting results. When the economic evaluation of a crop relies on a few specific traits, genotypic correlations become especially practical. They are influenced by factors such as pleiotropy, gene linkage, and natural or artificial selection (Kwon, 1965). The results for the genotypic correlation for twelve characters studied are presented in Table 1, which revealed that, the maximum correlation was observed between leaf length (LL) and number of leaves (NL) ($r=0.947$). This correlation suggests that as a sorghum plant produces more leaves, the individual leaves also tend to grow longer. The correlation between the number of leaves (NL) and leaf length (LL) in sorghum contributes to increasing yield, primarily through enhanced photosynthetic capacity, which supports overall plant growth and, consequently, the development of yield components. Similar findings were reported by Prakash *et al.* (2010), Goswami *et al.* (2020), Vinoth *et al.* (2021) and Kartik and Somu (2025).

The most important trait, grain yield per plant (GYPP) showed positive correlations with ear head weight (EHWT) ($r=0.80$), ear head width (EHW) ($r=0.716$), number of primaries per panicle (NPP) ($r=0.636$), number of leaves (NL) ($r=0.589$) and leaf length (LL) ($r=0.568$). Which inferred, breeders can focus on developing varieties that exhibit superior performance in ear head weight (EHWT), ear head width (EHW), number of primaries per panicle (NPP), number of leaves (NL), and leaf length (LL) to achieve higher grain yields. Also, the results were in accordance with those of Shivaprasad *et al.* (2019), Begija *et al.* (2021), Subalakshmi *et al.* (2019), Arunkumar (2013), Vinoth *et al.* (2021), and Pavan and Biradar (2022).

Some significant positive correlations were observed between the traits, hundred-seed weight and ear head length ($r=0.773$) were also observed, which implies that Sorghum plants that produce longer ear heads are likely to have heavier seeds, and vice-versa (Fanous *et al.*, 1971). Similar results were obtained by Vinoth *et al.* (2021), Pavan and Biradar (2022), Miriam *et al.* (2025). There were positive correlations between ear head weight (EHWT) and ear head width (EHW) ($r=0.772$), which were observed by Shivaprasad *et al.* (2019) and Pavan and Biradar (2022).

The trait, number of primaries per panicle (NPP), was significantly positively correlated with the number

of leaves (NL) ($r= 0.762$), leaf length (LL) ($r= 0.748$), ear head width (EHW) ($r= 0.716$), and ear head weight (EHWT) ($r= 0.659$). The number of primaries per panicle serves as a central hub in these correlations. A greater number of primaries provides more structural branches on the panicle where spikelets and ultimately grains can develop. The increase in primary branches is accompanied by enhanced vegetative growth (more and longer leaves); the plant has sufficient resources (photosynthates) to support the development of a larger number of grains on these numerous primaries (Sinha and Kumaravadivel, 2016). Furthermore, if these primaries also support wider and heavier ear heads, the individual primary branches are not merely abundant but also robust, capable of producing more or larger seeds. Therefore, these traits collectively indicate a plant with a higher capacity for both producing and filling grains, leading to a greater overall yield. Researches conducted by Vinoth *et al.* (2021), Pavan and Biradar (2022), Kartik and Somu (2025) have also given the same results. Also, there were positive correlations between the traits, days to fifty per cent flowering and days to maturity ($r= 0.635$), hundred seed weight and number of leaves (0.605), which concurred with the studies of Subalakshmi *et al.* (2019), Tefera *et al.* (2020), Bejira *et al.* (2021), Kartik and Somu (2025).

Negative correlation was observed between the traits hundred-seed weight and days to maturity ($r= -0.463$). Similar results were obtained in the studies conducted by Shivaprasad *et al.* (2019) and Goswami *et al.* (2020), which implies a negative correlation between hundred-seed weight and days to maturity suggests that sorghum varieties that mature earlier tend to have larger seeds, while those that mature later may have smaller seeds. Similarly,

A significant negative correlation of Grain yield per plant (GYPP) was observed with days to maturity (DM). A desirable outcome of a negative correlation is a shorter crop duration, which can lead to more economical cultivation of sorghum. This is particularly advantageous in regions with short growing seasons or where early harvest allows for multiple cropping cycles. Similar results were observed in the studies conducted by Tefera (2020) and Gebreyohannes *et al.* (2018).

Ear head length and days to fifty per cent flowering (-0.310) showed significant negative correlation. A negative correlation between ear head length and days to 50% flowering in sorghum suggests that varieties which flower earlier tend to have longer ear heads, and conversely, those that flower later may

have shorter ear heads and it might be possible to select for earlier flowering varieties that also possess longer ear heads, potentially leading to higher yields (Deepalakshmi, and Ganesamurthy, 2017). The results were in accordance with Arunkumar (2013), Pavan and Biradar (2022) and Kartik and Somu (2025).

Path-Coefficient Analysis

Profound comprehension of the association between two traits is indispensable for the concurrent selection of attributes, thereby accelerating genetic advancement in crop improvement programmes. Mere analysis and elucidation of association magnitude often culminate in an inefficient selection strategy under the influence of pleiotropism. Pleiotropy, a genetic entity, refers to a single gene governing multiple unrelated traits, as it encodes proteins participating in diverse biological pathways (Stearns 2010). Consequently, elucidating cause-and-effect relationships through path coefficient analysis to partition the direct and indirect influences of independent (secondary) variables on the dependent variable (grain yield) becomes imperative (Dong, 2024). Lenka and Mishra (1973) categorized path coefficients as negligible (0.00–0.09), low (0.10–0.19), moderate (0.20–0.29), high (0.30–0.99) and very high (> 1.0), respectively. To augment reliability and exactness in sorghum breeding programmes, foremost importance is assigned to traits exhibiting higher path coefficients. Derived from the observations recorded for genotypes in the present investigation, phenotypic and genotypic correlations were computed to assess the direct and indirect effects of yield and its component traits Table no. 2.

Highly significant positive direct effect on sorghum grain yield was observed on ear head length ($P_p= 1.219$), days to fifty per cent flowering ($P_p=1.108$), followed by ear head width ($P_p= 0.635$). Similar results were obtained in the study conducted by Arunkumar (2013), Prakash *et al.* (2010), Shivaprasad *et al.* (2019), Pavan and Biradar (2022), Miriam *et al.* (2025), Kartik and Somu (2025). The traits hundred seed weight ($P_p= -1.214$) and leaf length ($P_p= -0.529$) exhibited significant negative direct effects on grain yield. Shivaprasad *et al.* (2019), Subalakshmi *et al.* (2019), Vinoth *et al.* (2021), Pavan and Biradar (2022), Kartik and Somu (2025) also obtained the same results.

The present results on path analysis indicate that the ear head length, days to fifty per cent flowering, and ear head width were the most important components that manifested high and positive direct effect on fodder yield per plant and hence, these traits may be considered while selecting for high grain types in sorghum.

Table 1 : Genotypic correlation coefficient among yield and yield-related traits.

TRAITS	DFE	PHT	NL	LL	SD	DM	EHL	EHW	NPP	EHWT	HSW	GYPP
DFE	1**											
PHT	0.341*	1**										
NL	0.191 ^{NS}	0.667**	1**									
LL	0.235 ^{NS}	0.681**	0.947**	1**								
SD	-0.048 ^{NS}	0.216 ^{NS}	0.243 ^{NS}	0.257 ^{NS}	1**							
DM	0.635**	0.199 ^{NS}	-0.158 ^{NS}	-0.076 ^{NS}	-0.061 ^{NS}	1**						
EHL	-0.310*	0.523**	0.514**	0.480**	0.271 ^{NS}	-0.128 ^{NS}	1**					
EHW	-0.016 ^{NS}	0.502**	0.714**	0.726**	0.392*	-0.107 ^{NS}	0.554**	1**				
NPP	-0.027 ^{NS}	0.402**	0.762**	0.748**	0.247 ^{NS}	-0.128 ^{NS}	0.563**	0.747**	1**			
EHWT	0.041 ^{NS}	0.364*	0.595**	0.543**	0.323*	-0.239 ^{NS}	0.466**	0.772**	0.659**	1**		
HSW	-0.215 ^{NS}	0.468**	0.605**	0.505**	0.169 ^{NS}	-0.463**	0.773**	0.470**	0.467**	0.437**	1**	
GYPP	0.017 ^{NS}	0.270 ^{NS}	0.589**	0.568**	0.333*	-0.354*	0.363*	0.716**	0.636**	0.801**	0.331*	1**

* Significant at p=0.05 and ** Significant at p=0.01

Table 2 : Genotypic path coefficient among yield and yield related traits.

TRAITS	DFE	PHT	NL	LL	SD	DM	EHL	EHW	NPP	EHWT	HSW
DFE	1.108	-0.043	0.066	-0.125	0.000	-0.857	-0.378	-0.010	-0.003	-0.002	0.260
PHT	0.377	-0.126	0.230	-0.361	-0.001	-0.268	0.637	0.319	0.044	-0.014	-0.568
NL	0.211	-0.084	0.344	-0.501	-0.001	0.213	0.626	0.454	0.084	-0.022	-0.735
LL	0.261	-0.086	0.326	-0.529	-0.001	0.102	0.585	0.461	0.082	-0.020	-0.613
SD	-0.053	-0.027	0.084	-0.136	-0.006	0.083	0.330	0.249	0.027	-0.012	-0.205
DM	0.703	-0.025	-0.054	0.040	0.000	-1.350	-0.157	-0.068	-0.014	0.009	0.562
EHL	-0.343	-0.066	0.177	-0.254	-0.002	0.173	1.219	0.352	0.062	-0.017	-0.938
EHW	-0.017	-0.063	0.246	-0.384	-0.002	0.145	0.675	0.635	0.082	-0.029	-0.570
NPP	-0.030	-0.050	0.262	-0.396	-0.001	0.173	0.686	0.474	0.110	-0.025	-0.566
EHWT	0.045	-0.046	0.205	-0.288	-0.002	0.323	0.568	0.490	0.072	-0.037	-0.531
HSW	-0.238	-0.059	0.208	-0.267	-0.001	0.625	0.943	0.298	0.051	-0.016	-1.214

* Significant at p=0.05 and ** Significant at p=0.01

DFE: Days to fifty per cent flowering, PHT: Plant height (cm), NL: No. of leaves per plant, LL: Leaf length (cm), DM: Days to maturity, SD: Stem diameter (mm), EHL: Ear head length (cm), EHW: Ear head width (cm), EHWT: Ear head weight (g), NPP: Number of primary branches per panicle, HSW: Hundred seed weight (g), GYPP: Grain yield per plant (g).

References

- Adane Gebreyohannes, A. G., Taye Tadesse, T. T., Amare Seyoum, A. S., Habte Nida, H. N., Amare Nega, A. N., Tsegau Senbetay, T. S. and Chalachew Endalemaw, C. E. (2018). Genetic variability in agronomic traits and associations in sorghum [*Sorghum bicolor* (L.) Moench] genotypes at intermediate agro-ecology sorghum growing areas of Ethiopia.
- Angadi, K. S. and Somu, G. (2025). Genetic variability and association studies in grain sorghum (*Sorghum bicolor* L. Moench). *Plant Archives*, **25**(1).
- Arun Kumar, B. (2013). Genetic variability, character association and path analysis studies in sorghum (*Sorghum bicolor* (L.) Moench). *The Bioscan*, **8**(4), 1485–1488.
- Bejiga, T., Abate, B. and Teressa, T. (2021). Genetic variability and correlation of agronomic and malt quality traits in Ethiopian sorghum [*Sorghum bicolor* (L.) Moench] landraces at Sheraro, Northern Ethiopia. *African Journal of Plant Science*, **15**(7), 193–205.
- Chibvongodze, M. K., Gasura, E., Kamutando, C. N., Mabasa, S., Makovere, B., Nyakudya, E., Nhamo, A., Mtambanengwe, F. and Mapfumo, P. (2025). Potential traits for aiding selection for high grain yield based on trait association and path analysis in sorghum. *Journal of Underutilised Crops Research*, **4**(1), 23.
- Deepalakshmi, A. J. and Ganesamurthy, K. (2007). Studies on genetic variability and character association in kharif sorghum [*Sorghum bicolor* (L.) Moench]. *Indian Journal of Agricultural Research*, **41**(3), 177.
- Dong, Z. (2024). Wright's path analysis: Causal inference in the early twentieth century. *THEORIA*, **39**(1), 67–88.
- Falconer, D. S. (1981). *Introduction to quantitative genetics* (2nd ed.). Longman.
- Fanous, M. A., Weibel, D. E. and Morrison, R. D. (1971). Quantitative inheritance of some head and seed characteristics in sorghum [*Sorghum bicolor* (L.) Moench]. *Crop Science*, **11**(6), 787–789.
- Goswami, S. J., Patel, P. T., Gami, R. A., Patel, R. N. and Khatri, A. B. (2020). Correlation and path analysis study of different characters for grain yield and fodder purpose in sorghum [*Sorghum bicolor* (L.) Moench]. *Electronic Journal of Plant Breeding*, **11**(4), 1053–1061.
- Khan, M. M. H., Rafii, M. Y., Ramlee, S. I., Jusoh, M. and Al Mamun, M. (2022). Path-coefficient and correlation analysis in Bambara groundnut (*Vigna subterranea* [L.] Verdc.) accessions over environments. *Scientific Reports*, **12**(1), 245.
- Kumar, N. P. and Biradar, B. D. (2022). Studies on character association and path analysis for grain yield and yield attributes in rabi sorghum [*Sorghum bicolor* (L.) Moench]. *The Pharma Innovation Journal*, **11**, 4742–4745.

- Kwon, S. H. (1963). Genotypic and phenotypic correlations in a soybean cross. *Korean Journal of Crop Science*, **1**(1), 42–45.
- Lenka, D. and Misra, B. (1973). Path-coefficient analysis of yield in rice varieties. *Indian Journal of Agricultural Sciences*, **43**, 376–379.
- Neyhart, J. L., Lorenz, A. J. and Smith, K. P. (2019). Multi-trait improvement by predicting genetic correlations in breeding crosses. *G3: Genes, Genomes, Genetics*, **9**(10), 3153–3165.
- Paterson, A. H., Bowers, J. E. and Chapman, B. A. (2004). Ancient polyploidization predating divergence of the cereals, and its consequences for comparative genomics. *Proceedings of the National Academy of Sciences*, **101**(26), 9903–9908.
- Povilaitis, B. (1965). Genotypic correlations among certain quantitative characters in tobacco. *Canadian Journal of Genetics and Cytology*, **7**(3), 523–529.
- Prakash, R., Ganesamurthy, K., Nirmalakumari, A. and Nagarajan, P. (2010). Correlation and path analysis in sorghum (*Sorghum bicolor* L. Moench). *Electronic Journal of Plant Breeding*, **1**(3), 315–318.
- Shivaprasad, T., Girish, G., Badigannavar, A., Muniswamy, S., Yogesh, L. N. and Ganapathi, T. R. (2019). Genetic variability, correlation and path coefficient studies in sorghum [*Sorghum bicolor* (L.) Moench] mutants. *Electronic Journal of Plant Breeding*, **10**(4), 1383–1389.
- Sinha, S. and Kumaravadivel, N. (2016). Understanding genetic diversity of sorghum using quantitative traits. *Scientifica*, **2016**(1), 3075023.
- Stearns, S. C. (2010). Pleiotropy in evolutionary biology. *Nature Reviews Genetics*, **11**, 615–623.
- Subalakhshmi, V. K. S., Selvi, B., Kavithamani, D. and Vadivel, N. (2019). Relationship among grain yield and its component traits in sorghum (*Sorghum bicolor* (L.) Moench) germplasm accessions. *Electronic Journal of Plant Breeding*, **10**(2), 446–450.
- Tefera, A. (2020). Variability and association studies among the sorghum genotypes for seed yield and yield related traits under rainfed condition of Ethiopia. *Journal of Genetics, Genomics and Plant Breeding*, **4**(1), 9–19.
- Vinoth, P., Selvi, B., Senthil, N., Iyanar, K., Jeyarani, S. and Santhiya, V. (2021). Relationship between yield and yield contributing traits in sorghum [*Sorghum bicolor* (L.) Moench].