International Journal of Agricultural Research and Review
*Abbreviated Key Title: Int. J. Agric. Res Rev.*
**ISSN:** 2360-7971 (Print) & Open Access
**DOI:** 10.54978/ijarr.2023. v11: 9, Pp: 100-104

Volume-11 | Issue-9 September, 20223|

***Full length Research Paper***

# Genotypic and Phenotypic Correlation and Path Coefficient Analysis for Yield and Other Traits of Sorghum (Sorghum bicolour L. Moench) Land Races at Humid lowland and Intermediate agro-ecology of Ethiopia

**By**

**Habtamu Alemu Keba* and Habtamu Demelash Tamir**

**Ethiopian Institute of Agricultural Research (EIAR), Assosa Agricultural Research Center, Ethiopia**
**Email: halemu2017@gmail.com**

***Corresponding author: Habtamu AK** **Accepted:** 4/8/.2023 | **Published:** 5//9/2023

**Abstract:** *This Experiment was conducted to study the association among the yield contributing traits and their direct and indirect effects on the yield of sorghum. Knowing the association and path analysis of yield related traits is essential for breeders. So, this activity was conducted with the objectives of investigating the relationship among yield, yield related traits and their effect on yield. A total of 42 late and medium maturing sorghum genotypes were evaluated by using 7x6 triple lattice designs with three replications at Assosa in 2020 cropping season. For most of the investigated traits, the magnitudes of genotypic correlation coefficients were higher than the corresponding phenotypic correlation coefficients. This implies that there was inherent relationship between these traits. Grain yield showed significant and positive phenotypic and genotypic correlation with days to flowering, days to maturity, thousand grain weight and plant height. The strongest phenotypic association of grain yield was observed with thousand grain weight (r=0.82) followed by days to maturity (r= 0.63**) and days to flowering (r=0.53**). Apart from yield greater association was recorded between days to maturity and thousand grain weight (r= 0.65) followed by disease score with insect score (r=0.59). ). The strongest positive genotypic association was observed between grain yield and thousand grain weight (r=0.87**) followed by days to flowering and days to maturity (r= 0.78**) and thousand grain weight and days to maturity (r=0.78). Thousand grain weight has the highest positive direct (0.57) effect on grain yield while overall plant aspect has higher negative (-0.21) direct effect on grain yield.*

**Keywords:** Association, positive, inherent, direct effect, relationship

Quick Response Code



Journal Name: https://www.springjournals.net/

**Citation:** Habtamu AK and Habtamu DT (2023 Genotypic and Phenotypic Correlation and Path Coefficient Analysis for Yield and Other Traits of Sorghum (Sorghum bicolour L. Moench) Land Races at Humid lowland and Intermediate agro-ecology of Ethiopia. Int. J. Res. Rev. 11(9) Pp 100-104, 2023

**Published By IJARR**

## INTRODUCTION

Sorghum (Sorghum bicolor (L.) Moench) crop is inherently fit to warm and arid agro-ecologies which are characterized by recurrent water deficiency and thereby challenging for growing other crops. Sorghum is the fifth most important cereal crop in the world after maize, rice, wheat and barley and only second to maize in Ethiopian. As the climatic change is becoming the major force endangering agricultural production in arid and semi-arid regions of the globe, sorghum is the front runner crop to withstand the hardship and feed the world population depends on the produce. Sorghum producers are benefitting from the crop in many ways as food, feed for livestock, porridge, cultural (local) drinks as Tella and arake which were mainly known in Ethiopia. The stalk of the crop can also serve for fencing and other buildings.

In plant breeding, the presence of variability of the important trait which is under consideration is very important for the improvement of a crop. The primary task for plant breeders is maximizing selection efficiency to assist the identification of best genotypes with desired traits. The relationship between characters of the crop to be improved is of major importance for plant breeders. When selection is based on several plant characters, correlation analysis measures the intensity and direction of associations among characters that are important in a breeding program.

Studying the relationship between quantitative traits is very important for measuring the possibility of selecting two or more traits together and thereby evaluating the effect of selection for secondary traits on genetic gain for the primary trait under consideration. If the genetic correlation for both of the traits under consideration is positive, then the plant breeder can easily improve both traits at a time. It is so hard to decide the traits that fully contribute to yield when many characters are involved in trait association study because of the presence of some amount of interdependence. In this case, Path analysis is the good way of identifying main contributing character to the yield. The path coefficient analysis helps to determine the direct contribution of character and their indirect contributions via other characters (Tesfaye *et al.,* 2014). Path coefficient analysis measures the direct influence of one variable upon the other and permits separation of correlation coefficients in to component of direct and indirect components. Hence, the present study is aimed to analyze and determine the traits having greater association with yield utilizing the correlation and path analysis for different traits in sorghum.

## MATERIAL AND METHODS

Forty-two late and medium maturing sorghum land races collected from Wet lowland and intermediate agro-ecologies were used for the experiment (Table1). The experiment was carried out at Assosa Agricultural Research center (AsARC) during the main season of 2019/2020 cropping season. The testing site was among the potential areas for sorghum production in the wet lowland and intermediate agro-ecological zones of the country.

**Table1:** The experimental Materials used for the trial

| Genotype Number | Genotype | Genotype Number | Genotype |
|---|---|---|---|
| 1 | ETSCAs 10001-1-1-1 | 25 | AScol19-Kok001 |
| 2 | ETSCAs 10001-1-1-2 | 26 | Mok 079/1 |
| 3 | ETSCAs 10001-1-4-1 | 27 | AScol19-As-6 |
| 4 | ETSCAs 10002-2-13-1 | 28 | AScol19-KA021/1 |
| 5 | ETSCAs 10003-3-32-1 | 29 | Ya 036/1 |
| 6 | ETSCAs 10007-2-61-1 | 30 | Mok 079/2 |
| 7 | ETSCAs 10015-2-102-1 | 31 | AScol19-JW127 |
| 8 | ETSCAs 10015-2-103-1 | 32 | AScol19-BS 082/1 |
| 9 | ETSCAs 10016-1-106-1 | 33 | AScol19-Krm 124 |
| 10 | ETSCAs 10016-1-106-2 | 34 | AScol19-As -14 |
| 11 | ETSCAs 10019-1-110-1 | 35 | AScol19-AB126 |
| 12 | ETSCAs 10019-1-115-1 | 36 | AScol19-As-1 |
| 13 | ETSCAs 10020-2-116-1 | 37 | AScol19-SG 001 |
| 14 | ETSCAs 10020-2-116-2 | 38 | AScol19-As-13 |
| 15 | ETSCAs 10020-2-116-3 | 39 | AScol19-SG 002 |
| 16 | Y039-1 | 40 | AScol19-As-5 |
| 17 | AScol19-JW128 | 41 | Assosa-1 |
| 18 | AScol19-Krm123 | 42 | Bonsa |
| 19 | Assosa-1/1 | | |
| 20 | AScol19-As-7 | | |
| 21 | AScol19-Al25 | | |
| 22 | AScol19-As-2 | | |
| 23 | AScol19-As-8 | | |
| 24 | AScol19-Krm122 | | |

### Data collection

All agronomic data were collected on plot and plant bases using sorghum descriptors (IBPGR/ICRISAT, 1993). In each plot, randomly selected five plants were used to be measured for the plant based characters.

### Data analysis

The data was analyzed for Phenotypic and genotypic correlation coefficient

### Correlation Coefficients (r)

The observable correlation between two variables (Phenotypic correlation), which includes both genotypic and environmental components between the variables, was estimated using the formula suggested by Miller et al. (1958).

$$r\text{pxy} = \frac{\alpha 2\text{pxy}}{\sqrt{(\alpha 2\text{px})(\alpha 2\text{py})}}$$

Genotypic correlations were computed as:

$$\text{rgxy} = \frac{\alpha 2gxy}{\sqrt{(\alpha gx)(\alpha gy)}}$$

Where, $r_{pxy}$ is phenotypic correlation coefficient and $r_{gxy}$ is genotypic correlation coefficient between characters' x and y; $\sigma^2_{pxy}$ and $\sigma^2_{gxy}$ are phenotypic covariance and genotypic covariance between characters' x and y, respectively. $\sigma^2_{px}$ and $\sigma^2_{gx}$ are phenotypic and genotypic variances for character x and $\sigma^2_{py}$ and $\sigma^2_{gy}$ are phenotypic and genotypic variances for character y. Covariance analysis between all pairs of characters was calculated by the following formula; $Cov_{gxy} = (MSPg - MSPe)/r$ $Cov_{pxy} = COV_{gxy} + Cov_{exy}$ where, $Cov_{gxy}$= genotypic covariance between traits x and y $Cov_{pxy}$ = phenotypic covariance between traits x and y MSPg= Genotypic mean sum product of traits x and y MSPe = Environmental mean sum product of traits x and y,
r = Number of replication

### Path Coefficient Analysis

Path coefficient analysis involves a method of partitioning correlation coefficients in to direct effect and indirect effects through alternative pathways [Pathway (P) x correlation coefficient (r)] (Aryeetey and Laing, 1973). The path coefficients were obtained by solution of simultaneous equation through the method of least square as shown by Dewey and Lu (1959). Path coefficient is calculated by solving simultaneous equations which express the basic relationship between path coefficient and correlation coefficient.

## RESULTS AND DISCUSSION

Phenotypic and genotypic correlation coefficients were estimated for all possible pair of traits investigated in this trial.

### Correlation of grain yield with other agronomic traits

The results of assessment of the pair-wise associations among different agronomic traits indicated that some of the traits are positively correlated while others are negatively correlated which implies improving one traits had either positive or negative influence on the other traits.

Grain yield has showed highly significant (p<0.01) positive phenotypic correlation with days to flowering (r = 0.53), Days to maturity (r=0.63), Thousand grain weight (r= 0.82) and plant height (r= 0.49) (Table2). This implies that selection for these agronomic traits can enable the plant breeder to exploit higher grain yielding potential in sorghum. In the test environment, selecting sorghum genotypes with longer days to flowering and maturity, taller plant height and higher seed weight can significantly result in higher grain yield. Similar results have been reported by Alemayehu Assefa (2003) for strong positive correlation of grain yield with plant height, Mamo M and Mulgeta F. (2020) for strong positive correlation of grain yield with thousand Kernel weight. On the other hand, grain yield has showed highly significant (p<0.01) negative correlations with over all plant aspects (PAS, r= -0.74), insect score, (r= -0.33) and Bird damage (r=-0.63). Grain yield has showed non-significant negative association with disease score. Strong positive phenotypic association was observed for days to flowering and days to maturity (r=0.71**), days to maturity and thousand grain weight (r=0.65**), over all plant aspects and bird damage (r=0.64) while higher negative correlation was recorded for traits thousand grain weight and overall plant aspect (r= -73**), thousand grain yield and bird damage (r= -68) and days to maturity and insect score (r = - 0.48**

At genotypic level grain yield showed positive and highly significant correlations with days to flowering (r=0.57**), days to maturity (r= 0.7**), thousand grain weight (r= 0.87**) and plant height (r=0.53**) (Table 2). The strongest positive genotypic association was observed between grain yield and thousand grain weight (r=0.87**) followed by days to flowering and days to maturity (r= 0.78**) and thousand grain weight and days to maturity (r=0.78). This showed that the positively associated characters can be improved simultaneously and, improving one character can indirectly improve the other traits. Generally, the values of genotypic correlation coefficients were higher than the corresponding phenotypic correlation coefficients for most of the trait (Table2). This implies that there are inherent genotypic relationships between the tested traits. This result is in agreement with the previous findings of Tafere *et al* (2018), and Ezeaku and Mohammed (2006).

**Table 2:** Estimates of genotypic (above diagonal) and phenotypic (below diagonal) correlation coefficients for 9 sorghum traits

| | DTF | InSC | DsSc | BrdDmge | DTM | GYLD | PAS | THGW | PHT |
|---|---|---|---|---|---|---|---|---|---|
| DTF | 1 | -0.49** | -0.3ns | -0.59** | 0.78** | 0.57** | -0.53** | 0.67** | 0.54** |
| InSC | -0.29** | 1 | 0.72** | 0.33* | -0.55** | -0.44** | 0.4** | -0.48** | -0.42** |
| DsSc | -0.2ns | 0.59** | 1 | 0.16ns | -0.37* | -0.25ns | 0.14ns | -0.21ns | -0.49** |
| BrdDmge | -0.44** | 0.07ns | 0.02ns | 1 | -0.74** | -0.79** | 0.76** | -0.81** | -0.52** |
| DTM | 0.71** | -0.48** | -0.3** | -0.48** | 1 | 0.7** | -0.72** | 0.78** | 0.57** |
| GYLD | 0.53** | -0.33** | -0.19ns | -0.63** | 0.63** | 1 | -0.78** | 0.87** | 0.53** |
| PAS | -0.49** | 0.25* | 0.1ns | 0.64** | -0.6** | -0.74** | 1 | -0.78** | -0.43** |
| THGW | 0.6** | -0.33** | -0.16ns | -0.68** | 0.65** | 0.82** | -0.73** | 1 | 0.58** |
| PHT | 0.54** | -0.26* | -0.37** | -0.37** | 0.51** | 0.49** | -0.39** | 0.53** | 1 |

*, ** significant at 5% and 1%respectively, ns= non-significant, DTF=Days to flowering, InSC=Insect score, DsSc=Disease Score, BrdDmge=Bird damage, DTM=Days to maturity, GYLD=Grain yield, PAS=overall plant Aspect, THGW=thousand grain weight, PHT=plant height

**Path Coefficient Analysis**

Grain yield, being a dependent variable governed by many genes, is affected by many traits. So, the phenotypic and genotypic correlations were partitioned into direct and indirect effects for the traits that are believed to have a direct relationship with grain yield from the result of this study.

**Genotypic direct and indirect effects of various traits on grain yield**

The estimates of genotypic direct and indirect effects of the selected traits on grain yield were presented in (Table 3). Accordingly, genotypic path analysis showed that thousand grain weights (0.57) exerted the highest positive direct effect to grain yield followed by plant height (0.04). Mengesha et al (2019), and Chittapur and Biradar (2015) reported Similar result of direct positive correlation of plant height and thousand kernel weight on grain yield. Thousand grain weights had positive direct effect and the genotypic correlation with grain yield was positive and significant. Most of the traits scored negative direct effect on grain yield (Table3). The highest negative direct effect on grain yield was recorded for overall plant aspect or PAS (-0.21) followed by bird damage (-0.20), days to maturity (-0.07), insect score (-0.05) and days to flowering (-0.04). This implies that breeding for early maturing variety has a significant yield reduction due to the long growing period of the area. The negative direct effect of these traits has to be seriously considered because these traits contributed to grain yield reduction in the study area. Thousand grain weights has also the highest positive indirect effect on grain yield via days to maturity (0.45), days to flowering (0.38) and plant height (0.33). These positive indirect effects contribute to increase grain yield via increasing those traits. This result is similar to the findings reported previously by Khan et al., (2013). The genotypic residual value (0.20) indicated that the traits used in the genetic path analysis explained (80%) of the variation for grain yield.

In general, the trait association between yield and yield related traits in this particular study showed various magnitude of association which can be carefully considered for exploiting and selection to improve traits of interest in Ethiopian sorghum genotypes mainly land races collected from intermediate and humid lowland areas of the country. Regarding to the trait association, Singh and Chaudhary (1977) stated that whenever a trait has positive correlation and high positive indirect effects but negative direct effect on the economic trait like grain yield, emphasis should be given to the indirect effects.

Table3: Estimates of direct (bold diagonal) and indirect effect (off diagonal) at genotypic level of nine traits on grain yield

| | DTF | DTM | PHT | Insect SC | Bird damage | PAS | THGW | Residual |
|---|---|---|---|---|---|---|---|---|
| DTF | **-0.04** | -0.06 | 0.02 | 0.03 | 0.12 | 0.11 | 0.38 | 0.20 |
| DTM | -0.03 | **-0.07** | 0.02 | 0.03 | 0.15 | 0.15 | 0.45 | 0.20 |
| PHT | -0.02 | -0.04 | **0.04** | 0.02 | 0.10 | 0.09 | 0.33 | 0.20 |
| Insect SC | 0.02 | 0.04 | -0.02 | **-0.05** | -0.07 | -0.09 | -0.28 | 0.20 |
| Bird Damage | 0.02 | 0.05 | -0.02 | -0.02 | **-0.20** | -0.16 | -0.46 | 0.20 |
| PAS | 0.02 | 0.05 | -0.02 | -0.02 | -0.15 | **-0.21** | -0.45 | 0.20 |
| THGW | -0.02 | -0.06 | 0.02 | 0.03 | 0.16 | 0.17 | **0.57** | 0.20 |

R-square =0.80 DTF=Days to flowering, Insect SC=Insect score, DTM=Days to maturity, PAS=overall plant Aspect, THGW=thousand grain weight, PHT=plant height

## SUMMARY AND CONCLUSION

Knowledge of the relationships among different agronomic traits as well as their association with grain yield is of paramount importance in crop improvement. It is also important for assessing the feasibility of joint selection of two or more traits and hence for evaluating the effect of selection for secondary traits on genetic gain for the primary trait under consideration. Grain yield is a complex trait influenced either directly or indirectly by other traits of the crop which in turn governed by many types of gene. So, in order to improve a given crop, selection on the basis of grain yield alone may not result in effective and long lasting output. Grain yield is found to be positively and significantly associated with days to flowering, days to maturity, thousand grain yields and plant height at both phenotypic and genotypic level. So, positive genotypic correlation implies that the traits are associated inherently. Plant height and thousand grain weight have positive direct genotypic effect on grain yield while other traits have negative direct effect on grain yield. Generally, in order to bring a significant improvement on the grain yield of sorghum, special attention to be paid for days to flowering, days to maturity, thousand grain yields and plant height due to their significant correlation at both phenotypic and genotypic level with grain yield.

## REFERENCE


Tesfaye WM, Adugna W, Tsige G (2014). Correlation and Path Coefficient Analysis among Yield Component Traits of Ethiopian Mustard (Brassica Carinata a. Brun) at Adet, Northwestern, Ethiopia. J. Plant Sci. 2(2): 89-96

IBPGR/ICRISAT (1993). Descriptors for sorghum. IBPGR Secretariat, FAO, Rome, Iltay: pp. 1-26.

Miller, P.A., Williams, J. C., Robinson, H.F., & Comstock, R.E. (1958). Estimate of genotypic and environmental variances and co-variance in upland cotton and the implication selection. Agronomy Journal, 50, 126 131

Areyeetey AN, Laing E. 1973. Inheritance of yield components and their correlation with yield in cow pea. (Vigna unguiculata (L) Walp.). Euphytica, 22: 386

Dewey RR, Lu KH. 1959. A correlation coefficient analysis of components of crested seed production. Agronomy J, 51: 515- 518.

Alemayehu, A. (2003). Genetic variability and breeding potential of barley (Hordeum vulgare L.) landraces from North Shewa in Ethiopia," PhD Thesis, Faculty of natural and agricultural sciences university of Free State, Bloemfontein, South Africa. 226.

Mamo M, Worede F. 2020. Character association and Path analysis of sorghum (Sorghum bicolour (L.) Moench) genotypes for Striga resistance. BSJ Agri, 3(2): 96-102

Ezeaku IE, Mohammed SG (2006). Character association and path analysis in grain sorghum. African Journal Biotechnology 5(14):1337- 1340.

Tafere M., Sentayehu A. Taye T. and Dagne W.(2018). Correlation and Path Coefficient Analysis for Agronomical Traits of Lowland Adapted Ethiopian Sorghum Genotypes [Sorghum bicolor (L.) Moench] Genotypes. Journal of Biology, Agriculture and Healthcare,8(15).

Chittapur R, Biradar BD. 2015. Association studies between quantitative and qualitative traits in rabi sorghum. Indian J Agric Sci, 49(5): 468–471.

GH Mengesha, FM Hailemariam , TT Mindaye , B Lakew and RPS Verma.(2019). Correlation and path analysis of yield, yield contributing and malt quality traits of Ethiopian sorghum (Sorghum bicolor (L.) Moench) genotypes. Afr. J. Plant Sci. 13(8), pp. 209-220,

Singh RK, Chaudhary BD (1977). Biometrical Methods in Quantitative Genetic Analysis. Kalyani Publishers, New Delhi, 318 pp.

Khan HA, Shad SA, Akram W. Resistance to new chemical insecticides in the house fly, Musca domestica L., from dairies in Punjab, Pakistan. Parasitology research. 2013 May; 112:2049-54.