RESEARCH ARTICLE Agricultural Reviews, Volume 46 Issue 6: 968-975 (December 2025)

# Correlation and Path Coefficient Analysis of Fruit Yield and Yield Related Traits of Hot Pepper (*Capsicum annuum* L.) Landrace Genotypes at Raare Research Station, Eastern Ethiopia

Abdurazak Sufiyan[1]

10.18805/ag.RF-334


## ABSTRACT

**Background:** Hot pepper is an important spice used for flavoring, taste enhancement and coloring of food worldwide, with demand increasing over time.

**Methods:** The present study was conducted on 2022/2023 season to assess genetic variability in landrace accessions, characterize associations among traits and perform multivariate analysis under semi-irrigation conditions. The study evaluated 19 landrace and one improved hot pepper genotype using 12 quantitative and 9 qualitative parameters. A randomized complete block design with three replications was employed as the experimental design.

**Result:** High phenotypic and genotypic coefficients of variation, along with high genetic advance coupled with high heritability, were recorded for yield per plot, number of fruits per plant and fruit width, suggesting the potential for improvement through selection. Genotypic correlation coefficients were higher than their respective phenotypic correlation coefficients, indicating inherent associations among traits beneficial for breeding purposes. The results revealed that genotypic correlation of fruit yield per plot was highly significant and positively correlated with the number of fruits per plant (rg=0.370). The number of fruits per plant showed a high positive correlation with dry fruit yield per plot due to its high direct effect and indirect effects through plant height, number of flowers per plant, days to harvest and fruit width. Path analysis indicated that the number of fruits per plant exerts a direct positive effect on fruit yield through plant height, number of flowers per plant, days to harvest and fruit width. Therefore, selection based on these traits would be crucial for developing high-yielding varieties.


**Key words:** Correlation coefficient analysis, Genetic variability study, Haramaya university, Hot peppers, Path coefficient analysis.

## INTRODUCTION

Cited in (Rehima, 2006), Pepper is the world's second important vegetable ranking next to tomatoes and is the most produced type of spice used for flavoring, taste enhancer and coloring of food while providing vitamins and minerals. It is native of Mexico, which was brought into India from Brazil by Portuguese prior to 1785 AD. (Thamburaj, 2016). It is a common and widely distributed spices crop throughout the tropics. Over 100 species have been named under the genus Capsicum, but most workers recognize only two Species. *Capsicum annum* L. and *Capsicum frutescens* L. (Purseglove 1968). The genus *Capsicum*, which is commonly known as red chile, hot red pepper, chilli pepper, tabasco, paprika, cayenne, etc., belongs to the nightshade family *Solanaceae* (Amit, 2004). Pepper is a domesticated class of the plant genus Capsicum in the family *Solanaceae* (Greenleaf, 1986). The fruit of hot pepper (*Capsicum annum* L.) is a berry and may be green or yellow and becomes red when ripe. In the past, some woody forms of this species have been called *C. frutescent*, but the features that were used to distinguish those forms appear in many populations of *C. annuum* and there is no consistently recognizable *C. frutescent* species (Zhang *et al*., 2002). *Capsicum annuum* can be difficult to separate from the cultivated *C. chinense* (the hottest pepper) and *C. frutescens* (tabasco pepper) and their morphological features can overlap. These three species have the same ancestral gene pool and are sometimes very confusing with pepper, chilli, chile, chili, aji, paprika and capsicum all used interchangeably to describe the plant (DeWitt, 2009).

It is believed that chili was introduced to Ethiopia during 1520 to 1770 by the Portuguese. Today, Ethiopians consume chili in many different forms. Eating chili is a deeply rooted Ethiopian food habit. Nutritionally, chili is rich in vitamins A and C (Kibiru and Alemayehu, 2024). A large part of the vitamin intake for Ethiopians comes from chili. The daily consumption of chili pepper is about 15 grams per person.

[1]Ethiopia Biodiversity Institute, Harar Biodiversity Center, Ethiopia.

**Corresponding Author:** Abdurazak Sufiyan, Ethiopia Biodiversity Institute, Harar Biodiversity Center, Ethiopia.
Email: zakoahmado@gmail.com

**How to cite this article:** Sufiyan, A. (2025). Correlation and Path Coefficient Analysis of Fruit Yield and Yield Related Traits of Hot Pepper (*Capsicum annuum* L.) Landrace Genotypes at Raare Research Station, Eastern Ethiopia. *Agricultural Reviews*. **46(6):** 968-975. doi: 10.18805/ag.RF-334.

**Submitted:** 25-05-2024 **Accepted:** 30-04-2025 **Online:** 30-06-2025

In Ethiopia, chili is grown on approximately 246,000 ha, making it the second largest production area in the world. The crop is mainly cultivated on small patches of farmland. The average national yield is 400 kg $ha^{-1}$ of dry fruit (CPI, 2007).

Yield is a complex traits controlled by several simply inherited traits. Fruit yield is a complex trait and highly influenced by many genetic factors and environmental fluctuations whereas yield component traits are less complex in inheritance and influenced by the environment to a lesser extent. Therefore, direct selection for fruit yield as such could be misleading (Abrham *et al*., 2017). Correlation coefficient and path analysis offers a means of determining the important traits influencing the dependent trait such as seed yield and it also helps in the determination of the selection criteria for simultaneous improvement of various characters along with economic yield (Mohan and Thiyagarajan, 2019).

Correlation coefficient and path analysis offers a means of determining the important traits influencing the dependent trait such as seed yield and it also helps in the determination of the selection criteria for simultaneous improvement of various characters along with economic yield (Mohan and Thiyagarajan, 2019). Yield is a complex traits controlled by several simply inherited traits. Fruit yield is a complex trait and highly influenced by many genetic factors and environmental fluctuations whereas yield component traits are less complex in inheritance and influenced by the environment to a lesser extent. In plant breeding programme, direct selection for fruit yield as such could be misleading (Abrham *et al*., 2017). A successful selection depends upon the information on the genetic variability and association of morpho-agronomic traits with fruit yield. Correlation studies along with path coefficient analysis can provide a better understanding of the association of different traits with fruit yield. Path coefficient analysis separates the direct effects from the indirect effects through other related traits by partitioning the correlation coefficient (Berhanu *et al*., 2011b). Therefore, the aim of this study was to estimate correlation and path coefficient analysis of hot Pepper genotypes collected from Ethiopia grown at Haramaya University Main campus, Rare Research Station, Eastern Ethiopia.

## MATERIALS AND METHODS

### Description of study area

Study area of these field experiment was found in Haramaya woreda. Haramaya University is located in the Haro Maya district, East Hararghe Zone of the Oromia Regional State in Ethiopia. Haramaya University is situated approximately 510 kilometres (320 mi) east of Addis Ababa, the capital city of Ethiopia.

Rare research site is located at 9°26′N latitude, 42°3′E longitudes at an altitude of 1980 m.a.s.l. The mean annual rainfall is 760 mm (Belay *et al*., 1998). Mean annual temperature is 16°C (Mishra *et al*., 2004). The mean relative humidity is 50%, varying from 20 to 81%. The soil of the experimental site is alluvial type with organic carbon content of 1.15%, total nitrogen content of 0.11%, available phosphorus content of 18.2 mg kg $soil^{-1}$, exchangeable potassium content of 0.65 cmolc kg $soil^{-1}$, pH of 8.0 and per cent sand, silt and clay content of 62.92, 19.64 and 17.44, respectively (Simret, 2010).

**Table 1:** Passport of experimental material used for this study obtained from EBI.

| Accession no. | Region/region | Zone/zone | Woreda | Latitude | Longitude | Altitude |
|---|---|---|---|---|---|---|
| 20206 | Oromiya | Misrak wellega | Sasiga | 09-12-47-N | 36-25-52-E | 1667 |
| 20207 | Oromiya | Misrak wellega | Wama hagelo | 08-48-31-N | 36-55-12-E | 1597 |
| 20212 | Oromiya | Illubabor | Metu | 08-20-07-N | 35-35-08-E | 1678 |
| 20213 | Oromiya | Illubabor | Ale | 08-11-36-N | 35-32-27-E | 1758 |
| 20214 | Oromiya | Illubabor | Chora | 08-21-53-N | 36-03-13-E | 1652 |
| 27845 | SNNP | Bench maji | Gurra farda | 06-46-37-N | 35-11-50-E | 1408 |
| 27846 | SNNP | Bench maji | Gurra farad | 06-90-46-N | 35-18-32-E | 1121 |
| 28334 | Oromiya | Illubabor | Harrumu | 08-21-36-N | 35-43-39-E | 1657 |
| 28336 | Oromiya | Illubabor | Durame | 08-26-45-N | 35-52-54-E | 1868 |
| 28337 | Oromiya | Illubabor | Durame | 08-25-43-N | 35-52-48-E | 1877 |
| 28338 | Oromiya | Illubabor | Algae | 08-84-43-N | 35-45-60-E | 1831 |
| 229694 | Benishangul gumuz | Metekel | Dibate | - | - | 1640 |
| 229695 | Benishangul gumuz | Metekel | Dibate | - | - | 1650 |
| 229696 | Benishangul gumuz | Metekel | Dibate | | | 1700 |
| 229697 | Benishangul gumuz | Metekel | Dibate | - | - | 1440 |
| 229698 | Benishangul gumuz | Metekel | Dibate | - | - | 1520 |
| 229699 | Amara | Misrak gojam | Bibugn | 11-07-00-N | 37-44-00-E | 1850 |
| 229700 | Amara | Misrak gojam | Bibugn | 11-06-00-N | 37-44-00-E | 1830 |
| 229701 | Amara | Misrak gojam | Hulet ej enese | 11-05-00-N | 37-46-00-E | 1940 |
| M/fana | | | | | | |

**Planting material and experimental design**

Planting materials used for this study (Table 1 below) comprised of 20 genotypes among which 19 was treatment test with landrace genotypes maintained at EBI (Ethiopia Biodiversity Institute) and the other one genotypes was Marako fana (improved variety) used as check varieties which was obtained from Fedis Agricultural Research Center. Field experiment was conducted on 2022/2023 cropping season.

Experimental design was randomized complete block design (RCBD) with three replications. Seeds of each genotype was sown on seed bed size of 7.8 m × 2 m with a total seed bed area of 15.6 $m^2$ (each genotype was sown on two rows of 2 m long). Transplanting to the actual field was done when the seedlings attained 20 to 25 cm height and or at 40 days after sowing. Each seedling genotype was planted on plot size of 1.5 m × 2 m (with a total plot size of 3 $m^2$) and the distance between plots and between replication was 0.7 m and 1 m respectively. Each plot within a replication consists four rows and each row contains five plants with a total of 20 plants per plot. The Seedlings was spaced 50 cm between plants and 70 cm between rows. The experimental plots will be fertilized with 200 kg/ha DAP as a side dressing during the transplanting operation in addition, 100 kg/ha UREA, half of it during the transplanting and half of it 15 days after transplanting will be applied (EARO, 2004).

**Experimental procedure**

**Land preparation**

Larger clods was broken into small particles and finally attained into a desirable tilth to ensure proper growing conditions. Recommended doses of well decomposed cowdung, manure and chemical fertilizers was applied and mixed well with the soil of each plot. Proper irrigation and drainage channels was also prepared around the plots. Each unit plot was prepared keeping 5cm height from the drains. The bed soil will be made friable and the surface of the bed was leveled.

**Planting**

Seeds of 19 landrace genotypes plus 1 checks with a total of 20 genotypes was planted in April 2022 on seed bed. Seed bed was covered with a dry grass for 20 days and then, beds was covered by raised shade to protect seedling from strong sunshine until the plants be ready for transplanting. Fifty-five days after seeding, vigorous and healthy seedlings was selected and transplanted in the well prepared actual field. One seedling was planted in each hole. After planting, the bases of the seedlings were covered with soil and then was pressed by hand. Four days before planting of capsicum seedlings the entire amount of well decomposed cowdung and TSP and other fertilizers was applied to the plots and well mixed with the bed soil. During final bed preparation one fourth of both Urea and MP was applied. The rest of the Urea and MP was top dressed in 3 equal installments, after 30, 45 and 60 days of planting.

**Irrigation**

During initial phase of planting seed on seed bed, irrigation was used. After that semi-irrigation was used based on availability of rain.

**Cultural practices**

Mulching**,** Weeding, cultivation, watering and earthing-up was done at the appropriate time to facilitate root, to control disease infestation and to control waterlogging. Integrated Weeding and hoeing was done in order to improve soil structure and reduce competition of weeds and earthing-up was done as required to prevent exposure of roots to direct sunlight.

**Harvesting**

Harvesting of fruits was started at 75 DAP and continued up to 25 DAP with an interval of 25 days. Harvesting was done usually by hand. Five plants from each row or plot, left the plants growing at both ends of each row to avoid edge effects, was harvested to estimate fruit yield and other yield-related parameters.

**Data collection**

Quantitative (12) morphological data was collected according to the descriptor for Capsicum (IPGRI, 1995). At harvest, 10 guarded plants were randomly taken from each plot to measure quantitative morphological character. Some of the characters was measured prior to harvest. The sampling was done in such a way that the border effects were completely avoided. For this purpose, the outer two lines and the extreme end of the middle rows was excluded. The following quantitative morphological data was collected.

**Quantitative characters measured**

1. **Plant height (PH):** Length in centimeter of the central axis of the stem, measured from the soil surface up to the tip of the stem and the average was recorded. Recorded when in 50% of the plants the first fruit has begun to ripen.
2. **Days to 50% flowering (DFL):** Number of days from transplanting to when 50% of plants in a plot open the flower.
3. **Days to 50% fruiting (DF):** Number of days from transplanting until 50% of the plants bear mature fruits at the first and second bifurcation. Recorded on mature fruits.
4. **Number of flower per axil (NFLA):** The number of flower counted per axil recorded on fully open flower.
5. **Days to first harvest (DH):** Number of days from transplanting to first harvest.
6. **Number of fruits per plant (NFP):** Average number of chili fruits, counted at harvest on 10 sample plants of each plot.
7. **Fruit length (FL):** Average length of five chili fruits was measured in centimeter on 10 plants of each plot.
8. **Fruit width (FW):** Measured at the widest point. Average fruit width of 10 ripe fruits.
9. **Fruit Weight (FWT):** Average fruit weight of 10 ripe fruits of the second harvest.

10. **Number of seed per fruit (NSF):** Average of at least 10 fruits selected from 10 random plants.
11. **1000-seed weight [g] (TSW):** The weight of 1000 seed in measured each plots.
12. **Yield per plot [kg] (FYPP):** The weights of total fruits harvested in each plot from all central row plants were recorded to estimate yield per plot.

**Data analysis**

Correlation and path coefficient analysis was performed according to (Singh and Chaudhry, 2001). Estimation of correlation coefficient will be performed using Statistical software system Version 9.2 (SAS, 2008).

$$rg = Gcovx.y / \sqrt{(\sigma 2gx. \sigma 2gy)}$$

Where,
rg = Genotypic correlation coefficient.
Gcovx.y = Genotypic covariance between variables x.
y,σ2gx = Genotypic variance for variable x.
σ2gy= genotypic variance for variable y.

$$rp = Pcovx.y / \sqrt{(\sigma 2gx. \sigma 2gy)}$$

Where,
rg = Genotypic correlation coefficient.
Gcovx.y = Genotypic covariance between variables x.
y,σ2gx = Genotypic variance for variable x.
σ2gy = Genotypic variance for variable y.

Path coefficient analysis will be performed using OPSTAT online statistica package software for agricultural worker to study the direct and indirect contribution of traits to the association. A measure of direct and indirect effects of each character on fruit yield will be estimated using a standardized partial regression coefficient known as path coefficient analysis, as suggested by Dewey and Lu, (1959).

$$rij = pij + \Sigma rikpjk$$

Where:
rij = The association between independent variables (i) and dependent variables (j) as measured by phenotypic and genotypic correlation coefficient.
Pij = Component of direct effect of independent variable (i) on the dependent variable (j) as measured by the phenotypic and genotypic path coefficient.
Σrikpjk = Summation of components of indirect effect of a given independent variable (i) on a given dependent variable (j) *via* all other independent characters.

The residual effect, which determines how best the causal factors account for the variability of the dependent factor, was calculated as described by Dewey and Lu *et al*. (1959):

$$1 = P2\ r + \Sigma pij.\ Rij$$

Where,
P2 r = Residual factor.
Pij = Direct effect of yield by ith trait on $j^{th}$ trait.
rij = Correlation of dependent variable with the ith trait.

Small P2R value (P2R, nearly zero) indicates that the dependent trait considered (yield) is fully explained by the variability in the independent traits.

Higher P2R value indicates that some other factors which have not been considered need to be included in the analysis to account fully for the variation in the dependent trait.

## RESULT AND DISCUSSION

**Correlation coefficient analysis**

The correlation coefficient analysis measures the mutual relationship between various characters and it determines the component traits on which selection can be relied upon to affect the improvement. There are three types of correlations *viz*., phenotypic, genotypic and environmental correlations. Phenotypic correlation is the observable correlation between two variables and includes both genotypic and environmental effects. Genotypic correlation on the other hand, is the inherent association between two variables may be either due to pleiotropic action of genes or linkage, more likely both or developmentally induced relationships. Thus, when two characters correlated among themselves and also correlated with yield is due to pleiotropy, but if they are not correlated with yield their association might be due to linkage (Kumar *et al*., 2003).

**Phenotypic and genotypic correlation between fruit yield and other fruit yield related trait**

Genotypic phenotypic correlation coefficient was given in Table 2. From the Table 2 we observed, in most cases, the genotypic correlation coefficients were higher than their respective phenotypic correlation coefficients indicating their inherent association of traits and hence more advantageous for breeding purposes. From their study, Shumbulo *et al*. (2017) also noted that in most cases genotypic correlation of were higher than phenotypic correlation coefficient.

Present study revealed that genotypic correlation of fruit yield per plot is highly significantly and positively correlated with number of fruit per plant (rg = 0.370). This indicates that there is strong association between fruit number per plant and fruit yield per plot. Similar findings on Hot pepper were reported by (Yatung *et al*., 2014) for fruit number per plant. Therefore, number of fruit per plant is useful for selecting productive genotype. Fruit length (rg= -0.557) and days to flowering (rg= -0.401) showed that significant and negative correlation with fruit yield per plot.

Genotypic correlation showed that plant height (rg= 0.030), days to harvest (rg= 0.008) and thousand seed weight (rg= 0.0069) found to be non-significant and positively correlated with fruit yield per plot, whereas non-significant and negative correlations with fruit yield per plot was shown by days to fruiting (rg= -0.119), number of flower per plant (rg= -0.198), fruit width (rg= -0.209), fruit weight (rg= -0.193) and number of seed per fruit.

With regard to phenotypic correlation, fruit yield only significantly and negatively correlated with days to flowering

**Table 2:** Genotypic (above diagonal) and phenotypic (below diagonal) correlation of 12 quantitative trait of hot pepper.

| | PH | DFL | DF | NFLA | DH | FL | FW | FWT | NFP | NSF | 1000SW | FYPP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PH | 1 | 0.447** | -0.358** | 0.402** | -0.052NS | 0.180NS | -0.247NS | 0.101NS | -0.334** | -0.191NS | 0.328* | 0.030NS |
| DFL | 0.367** | 1 | -0.320* | 1.037** | -0.552** | -0.265* | 0.163NS | -0.317* | -0.015NS | 0.060NS | -0.112NS | -0.401** |
| DF | -0.297* | -0.168NS | 1 | -1.167** | 0.119NS | -0.181NS | -0.137NS | 0.322* | 0.099NS | 0.311* | 0.388** | -0.119NS |
| NFLA | 0.126NS | 0.203NS | -0.064NS | 1 | -2.360** | 1.154** | 0.484** | -2.148** | -0.829** | -0.215NS | 0.178NS | -0.198NS |
| DH | -0.024NS | -0.170NS | -0.021NS | -0.236NS | 1 | -0.825** | 0.033NS | 0.391** | 0.847** | -0.536** | -0.005NS | 0.008NS |
| FL | 0.022NS | -0.169NS | 0.093NS | 0.315* | -0.207NS | 1 | 0.062NS | -0.231NS | -0.406** | 0.123NS | 0.845** | - 0.557** |
| FW | -0.239NS | 0.107NS | -0.023NS | 0.146NS | -0.071NS | -0.044NS | 1 | -0.766** | 0.608** | 0.761** | -0.759** | -0.209NS |
| FWT | -0.028NS | -0.090NS | 0.244NS | 0.017NS | 0.119NS | -0.025NS | -0.130NS | 1 | -0.460** | -0.125NS | -0.792** | -0.193NS |
| NFP | -0.167NS | 0.037NS | -0.006NS | -0.074NS | 0.324* | -0.310* | 0.367** | 0.020NS | 1 | 0.324* | -0.328* | 0.370** |
| NSF | -0.062NS | 0.050NS | 0.186NS | -0.031NS | -0.135NS | -0.018NS | 0.418** | -0.188NS | -0.008NS | 1 | -0.279* | -0.166NS |
| TSW | 0.074NS | -0.077NS | 0.159NS | -0.202NS | -0.169NS | 0.032NS | -0.104NS | -0.030NS | -0.145NS | -0.180NS | 1 | 0.069NS |
| YPP | 2 0.148NS | -0.261* | -0.094NS | 0.169NS | 0.057NS | 0.234NS | -0.066NS | -0.028NS | 0.111NS | -0.009NS | 0.037NS | 1 |

PH: Plant height, DFL: Days to 50% flowering, DF: Days to 50% Fruiting, NFLA: Number of flower per axil, DH: Days to first harvest, FBP: Fruit bearing period, NFP: Number of fruits per plant, FL: Fruit length, FW: Fruit width, FWT: Fruit weight, NSF: Number of seed per Fruit, 1000 SW: 1000-seed weight. * indicates significant at 1%, ** indicates significant at 1% and NS indicates non-significant.

(rp= -0.261). Non-significant and positive correlation was observed between fruit yield and plant height, number of flower per plant, day to maturity, fruit length, number of fruit per plant and thousand seed weight, while non-significant and negative correlation was observed between fruit yield per plot and days to fruiting, fruit weight, fruit width and number of seed per fruit.

**Phenotypic and genotypic correlation among yield related traits**

Genotypic correlation above diagonal (Table 2) indicated that days to harvest and number of seed per frut was significantly and positively correlated with number of fruits per plant which indicate that improvement in these traits would enhance number of fruits per plant and in turn yield. Days to fruiting was significantly and positively correlated with fruit weight and number of seed per fruit. Also, fruit weight indicated positive and significant correlation with days to fruiting and days to harvesting. In addition, significant and positive correlation was shown by plant height with days to flowering and number of flowering per plant. Moreover, number of flower per plant showed significant and positive correlation with days to flowering, fruit length and fruit width. Furthermore, thousand seed weight indicated significant and positive correlation with plant height, days to flowering and fruit length.

Moreover, from genotypic correlation significant and negative correlations was seen in wide range of traits. Days to flowering was significant and negatively correlated with days to fruiting, days to harvest, fruit length and fruit width. Number of fruit per plant indicated significant and negative correlation with fruit length, fruit weight, plant height and thousand seed weight. Moreover, days to harvest was significantly and negatively correlated with days to fruiting, number of seed per fruit and fruit length. In addition to this, number of flower per plant indicated that significant and negative correlation with days to harvest, fruit weight, number of fruit per plant and days to harvest. The trait, thousand seed weight showed significant and negative correlation with fruit weight, fruit width and number of seed per fruit.

Furthermore, taking genotypic correlation as a reference, its noted that non-significant and positive correlation was shown between number of fruit per plant and days to fruiting and also between days to harvest and days to fruiting, while non-significant and negative correlation was indicated between number of fruit per plant and days to flowering and also between days to harvest and plant height.

Generally, genotypic correlation between fruit yield and yield related traits indicated that number of fruit per plant is an important yield component because it's highly significantly and positively correlated with fruit yield which indicated their strong association. Therefore, it's recommended that fruit yield of hot pepper can be increased by giving these trait priorities in selection of genotype for improvement purpose and subsequent selection is of immense importance.

**Table 3:** Phenotypic direct (bolded and diagonal) and indirect (unbolded and outside of diagonal) of 11 quantitative character.

| characters | PH | DFL | DF | NFLA | DH | FL | FW | FWT | NFP | NSF | 1000SW | rp |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PH | 0.22210 | -0.13484 | 0.04101 | 0.02820 | -0.00043 | 0.00435 | 0.04039 | 0.00053 | -0.05240 | -0.00940 | 0.00817 | 2 0.148NS |
| DFL | 0.08146 | -0.36766 | 0.02322 | 0.04530 | -0.00310 | -0.03409 | -0.01805 | 0.00166 | 0.01155 | 0.00750 | -0.00853 | -0.261* |
| DF | -0.06603 | 0.06190 | -0.13792 | -0.01424 | -0.00038 | 0.01883 | 0.00391 | -0.00450 | -0.00180 | 0.02820 | 0.01766 | -0.094NS |
| NFLA | 0.02809 | -0.07471 | 0.00881 | 0.22296 | -0.00430 | 0.06365 | -0.02465 | -0.00032 | -0.02333 | -0.00463 | -0.02233 | 0.169NS |
| DH | -0.00524 | 0.06257 | 0.00290 | -0.05258 | 0.01824 | -0.04172 | 0.01207 | -0.00219 | 0.10166 | - 0.0204 | -0.01868 | 0.057NS |
| FL | 0.00478 | 0.06208 | -0.01286 | 0.07028 | -0.00377 | 0.20191 | 0.00744 | 0.00046 | -0.09730 | -0.00267 | 0.00354 | 0.234NS |
| FW | -0.05303 | -0.03924 | 0.00319 | 0.03250 | -0.00130 | -0.00888 | -0.16914 | 0.00240 | 0.11531 | 0.06330 | -0.01150 | -0.066NS |
| FWT | -0.00633 | 0.03307 | -0.03361 | 0.00383 | 0.00217 | -0.00499 | 0.02200 | -0.01846 | 0.00630 | -0.02841 | -0.00332 | -0.028NS |
| NFP | -0.03708 | -0.01353 | 0.00079 | -0.01657 | 0.00591 | -0.06258 | -0.06213 | -0.00037 | 0.31391 | -0.00121 | -0.01610 | 0.111NS |
| NSF | -0.01381 | -0.01822 | -0.02571 | -0.00682 | -0.00247 | -0.00356 | -0.07077 | 0.00347 | -0.00252 | 0.15127 | -0.01999 | -0.009NS |
| TSW | 0.01638 | 0.02829 | -0.02198 | -0.04494 | -0.00307 | 0.00645 | 0.01756 | 0.00055 | -0.04561 | -0.02729 | 0.11081 | 0.037NS |

R (Residual effect) = 0.72300.

**Table 4:** Genotypic direct (bolded and diagonal) and indirect (unbolded and outside of diagonal) of 11 quantitative character.

| Characters | PH | DFL | DF | NFLA | DH | FL | FW | FWT | NFP | NSF | 1000SW | rg |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PH | -1.498 | 1.08194 | 0.04157 | -0.15891 | -0.04971 | 0.53906 | -0.30047 | 0.16429 | -0.18673 | 0.24324 | 0.15412 | 0.030NS |
| DFL | -0.66917 | 2.422 | 0.03720 | -0.41035 | -0.53308 | -0.79117 | 0.19821 | -0.51679 | -0.00836 | -0.07634 | -0.05260 | -0.401** |
| DF | 0.53614 | -0.77564 | -0.116 | 0.46203 | 0.11485 | -0.54103 | -0.16703 | 0.52509 | 0.05559 | -0.3951 | 0.18214 | -0.119NS |
| NFLA | -0.60144 | 2.51107 | 0.13559 | -0.39578 | -2.27756 | 3.44560 | 0.59001 | -3.49941 | -0.46332 | 0.27395 | 0.08347 | -0.198NS |
| DH | 0.07716 | -1.33794 | -0.01382 | 0.93413 | 0.965 | -2.46273 | 0.04016 | 0.63671 | 0.47340 | 0.68242 | -0.00235 | 0.008NS |
| FL | -0.27034 | 0.64151 | 0.02104 | 0.45656 | 0.79563 | 2.987 | 0.07535 | 0.37583 | 0.22701 | 0.15688 | 0.39711 | - 0.557** |
| FW | 0.36924 | 0.39384 | 0.01592 | 0.19158 | 0.03179 | 0.18463 | 1.21892 | 1.24694 | 0.34019 | 0.96851 | -0.35645 | -0.209NS |
| FWT | -0.15108 | -0.76837 | -0.03744 | 0.85026 | 0.37719 | -0.68916 | -0.93309 | 1.62891 | -0.25724 | 0.15922 | -0.37212 | -0.193NS |
| NFP | 0.50025 | -0.03619 | -0.01155 | 0.32796 | 0.81701 | -1.21267 | 0.74162 | -0.74941 | 0.55913 | -0.41191 | -0.15414 | 0.370** |
| NSF | 0.28645 | 0.14535 | 0.03608 | 0.08524 | 0.51770 | 0.36838 | 0.92810 | 0.20390 | 0.18106 | 1.27199 | -0.13122 | -0.166NS |
| TSW | -0.49142 | 0.27118 | 0.04503 | 0.07032 | 0.00484 | 2.52481 | 0.92485 | 1.29023 | 0.18345 | 0.35528 | 0.470 | 0.069NS |

With regard to phenotypic correlation below diagonal (Table 3), significant and positive correlation was observed between number of fruit per fruit and days to harvest (rp= 0.324), between number of fruit per plant and fruit width (rp= 0.367), number of seed per fruit and fruit width (rp= 0.418), days to harvest and fruit length (rp= 0.315) and between plant height and days to flowering (rp= 0.367). Significant and negative correlation was observed between plant height and days to fruiting (rp= -0.297) and between fruit length and number of fruit per plant (rp= -0.310).

Furthermore, phenotypic correlation of days to fruiting, days to harvest and number of flower per plant showed non-significant and positive correlation with fruit weight. Moreover, number of fruit per plant showed non-significant and positive correlation with days to flowering and fruit weight. In addition, significant and positive correlation was found between plant height and number of flower per plant, plant height and fruit length, number of flower per plant and days to flowering, days to flowering and fruit width and between days to harvest and fruit width.

**Path coefficient analysis**

Cruz (2006) stated that since of the correlations among traits does not consider the cause / effect relationships between primary and secondary traits, determinants of yield, the method called path analysis was developed and consists in studying the direct and indirect effects of traits on a basic variable. Path analysis helps in partitioning of correlation coefficients into direct and indirect effects, permitting a critical examination of the relative importance of each trait (Kumar *et al*., 2003). Therefore, the path analysis was conducted for current study and presented as follows.

**Phenotypic and genotypic direct effect and indirect effect**

Genotypic and phenotypic correlations of the 11 quantitative characters were partitioned to phenotypic direct indirect effect and genotypic direct indirect were presented in Table 3 and Table 4 respectively below which enabled us to identify character having direct effects on fruit yield.

Path coefficient analysis from genotypic correlation using fruit yield as dependent variable other as independent variable indicated that days to flowering (2.422), days to harvest (0.965), fruit length (2.987), fruit width (1.21892), fruit weight (1.62891), number of fruit per plant (0.55913), number of seed per fruit (1.27199) and thousand seed weight (0.470). However, plant height, days to fruiting and number of flower per plant showed negative direct effect. Number of fruit per plant exert direct positive effect (0.55913) through plant height, number of flower per plant, days to harvest and fruit width. Number of fruit per plant showed high positive correlation with dry fruit yield per plot is due to its high direct effect and indirect effect through plant height, number of flower per plant, days to harvest and fruit width. This finding is similar with the result of the previous report by Yatung *et al*. (2014) for direct effect of number of fruit per plant on yield. The highly significant positive association of number of fruit per plant and dry fruit yield per plot were the result of positive indirect effect of these traits *via* plant height, number of flower per plant, days to harvest and fruit width and also some individual direct effect of number of fruits per plant towards dry fruit yield per plot. Therefore, selection on the basis of those trait would be of great importance for developing high yielding varieties.

Number of seed per fruit exerts direct postive effect through all trait except thousand seed weight. However, thousand seed weight exerts direct positive effect through all character except plant height.

Path coefficient analysis from phenotypic correlation using fruit yield as dependent variable other as independent variable indicated that plant height (0.22210), number of flower per plant (0.22296), days to harvest (0.01824), fruit length (0.20191), number of fruit per plant (0.31391), number of seed per fruit (0.15127) and thousand seed weight (0.11081) revealed positive direct effect on dry fruit yield. However, days to flowering, days to fruiting, fruit weight and fruit width had negative direct effect on fruit yield.

Number of seed per fruit exert direct positive effect (0.15127) only through fruit weight. Days to harvest employed direct positive effect (0.01824) on fruit yield per plot as well as indirect positive effects *via* days to flowering, days to fruiting, fruit width and number of fruit per plant. However, stem width exerts indirect negative effect on fruit yield per plot through plant height, number of flower per plant, fruit length, fruit weight, number of seed per fruit and thousand seed weight.

## CONCLUSION AND RECOMMENDATION

Present study revealed that genotypic correlation of fruit yield per plot is highly significantly and positively correlated with number of fruit per plant (rg= 0.370). This indicates that there is strong association between fruit number per plant and fruit yield per plot. Therefore, number of fruit per plant is useful for selecting productive genotype.

Path coefficient analysis indicated why number of fruit per plant correlated significantly and positevly with yield per plot. Accordingly, number of fruit per plant exert direct positive effect (0.55913) through plant height, number of flower per plant, days to harvest and fruit width. Number of fruit per plant showed high positive correlation with dry fruit yield per plot is due to its high direct effect and indirect effect through plant height, number of flower per plant, days to harvest and fruit width.

In other word, highly significant positive association of number of fruit per plant and dry fruit yield per plot were the result of positive indirect effect of these traits *via* plant height, number of flower per plant, days to harvest and fruit width and also some individual direct effect of number of fruits per plant towards dry fruit yield per plot. Therefore, selection on the basis of those trait would be of great importance for developing high yielding varieties.

From the result of these study, the following points are suggession and recommedation are forwarded:

1. From path analysis result, it was noted that number of fruit per plant exert direct postive effect through plant height, number of flower per plant, days to harvest and fruit width. Hence, number of fruit per plant showed high positive correlation with dry fruit yield per plot is due to its high direct effect and indirect effect through plant height, number of flower per plant, days to harvest and fruit width. Therefore, plant height, number of flower per plant, days to harvest and fruit width should be considered during selection.
2. It has been said morphological characterization coupled with molecular will be of immense importance in genetic variablity since they support each other. But this study only considered morphological traits and therefore, molecular study for similar accession should be considered.
3. This study was carried out with 19 accessions and 1 check varieties so more accessions and varieties from different environment should be included for further study.

**Conflict of interest**

Author declared that there is no conflict of interest.

## REFERENCES


Abrham, S., Mandefro, N., Sentayehu, A. (2017). Correlation and path coefficient analysis of hot pepper (*Capsicum annuum* L.) genotypes for yield and its components in Ethiopia. *Advances in Crop Science and Technology*. **5(3):** 2329-8863.

Amit, K.D. (2004). Capsicum: The genus Capsicum. Medicinal and Aromatic Plants - Industrial Profiles, Taylor and Francis Group, London and New York.

Belay, S.C., Wortman, W. and Boom, G.H. (1998). Haricot bean agro-ecology in Ethiopia: Definition using agro-climatic and crop growth stimulation models. *African Crop Science Journal*. **6:** 9-18.

Berhanu, Y., Derbew, B., Wosene, G., Fedaku, M. (2011b). Genetic association among some attributes of Hot Pepper (*Capsicum annuum* L.) Genotypes in West Shoa, Ethiopia. Middle East *Journal of Scientific Research*. **7(4):** 567-573.

CPI (Chile Pepper Institute) Publication. (2007). New Mexico State University.

Cruz, C.D., Carneiro, P.C.S. (2006). Modelos Biométricos Aplicados ao Melhoramento Genético. [Viçosa, M.G. (ed)]. Editora UFV. **2:** 585.

Dewey, D.R. and Lu, K.H. (1959). A correlation and path-coefficient analysis of components of crested wheatgrass seed production. *Agronomy Journal*. **51:** 515-518.

DeWitt, D. and Bosland, P.W. (2009). Complete Chile Pepper Book: A Gardener's Guide to Choosing, Growing, Preserving and Cooking, Timber Press.

EARO (Ethiopian Agricultural research Organization). (2004). Released crop varieties and their recommended cultural practices. Progress report. Addis Ababa, Ethiopia.

Green leaf, W.H. (1986). Pepper breeding in Breeding Vegetable Crops, (Basset, M. J. Eds), The AVI Publishing Company, Westport, Conn, USA. pp. 67-134.

IPGRI. (1995). Descriptors for capsicum (*Capsicum* sp.). Rome, Italy.

Kena, K., Latera, A. (2024). Effect of NPS and nitrogen fertilizer application rates for small pod hot pepper production (*Capsicum annuum* L.) variety at kellem and West Wollega Zones. *Agricultural Reviews*. **45(1):** 170-176. doi: 10.188 05/ag.RF-296.

Kumar, B.K., Munshi, A.D., Joshi, S. and Kaur, C. (2003). Note on evaluation of chilli (*Capsicum annuum* L.) genotypes for biochemical constituents. *Capsicum Eggplant Newsl.* **22:** 41-42

Mishra, B.B., Kidan, H.G., Kibret, K.M., Assen and Eshetu, B. (2004). Soil and land resource inventory at Alemaya University research farm with reference to land evaluation for Sustainable Agricultural Management and Production. Synthesis of Working Papers, Soil Science Bulletin No. 1. Alemaya University, Ethiopia.

Mohan, S. and Thiyagarajan, K. (2019). Genetic variability, correlation and path coefficient analysis in chickpea (*Cicer arietinum* L.) for yield and its component traits. *International Journal of Current Microbiology and Applied Sciences.* **8(05):** 2319-7706. Journal homepage: http://www.ijcmas.com.

Purseglove, J.W. (1968). TropicaL crops, Dichotyledons. John Wiley and Sons, New York. 2: 524-530.

Rehima, M. (2006). Analysis of red pepper marketing. The case of alaba and siltie in SNNPRS of Ethiopia. A Thesis submitted to Department of Agricultural Economics School of Graduate studies Haromany University. pp. 1-8.

SAS, (2008). Statistical Analysis Software.

Shumbulo, A., Nigussie, M., Alamerew, S. (2017). Correlation and path coefficient analysis of hot pepper (*Capsicum annuum* L.) genotypes for yield and its components in Ethiopia. *Adv. Crop. Sci. Tech*. **5:** 277. doi: 10.4172/2329-8863. 1000277.

Simret, B. (2010). Influence of inorganic nitrogen and potassium fertilizers on seed tuber yield and size distribution of potato (*Solanum tuberosum* L.). An. M. Sc Thesis Presented to the School of Graduate Studies of Haramaya University, Ethiopia. pp. 65

Singh, N.P., Choudhary, A.K. and Choudhary, S.P.S. (2001). Variability and correlation studies in some genotypes of clusterbean. *Advances in Arid Legume Research*. **2(1):** 14-18.

Thamburaj, S. (2016). Textbook of Vegetables, Tubercrops and Spices. New Delhi. *Indian Council of Agricultural Research*. pp. 469

Yatung, T., Dubey, R., Singh, V., Upadhyay, G. and Pandey, A.K. (2014). Selection parameters for fruit yield and related traits in chilli (*Capsicum annuum* L.). *Bangladesh Journal of Botany*. **43(3):** 283-291.

Zhang, Z., Lu, A. and D'arcy, W.G. (2002). *Capsicum annuum* Linnaeus, Special Plant. *Flora of China*. **17:** 313-313.