Novelty Journals

ISSN 2394-966X

International Journal of Novel Research in Life Sciences
Vol. 7, Issue 2, pp: (1-9), Month: March - April 2020, Available at: www.noveltyjournals.com

Correlation and Path analysis Studies among Yield and Yield Related Traits of Maize (*Zea mays* L.) Inbred lines in Moisture Stress area, Melkassa, Ethiopia

Talefe Wedwessen[1], Legesse wolde[2]

Ethiopian Institute of Agricultural Research, Melkassa Agricultural Research Center, P.O.Box: 436, Adama, Ethiopia,

Email*:tseen21@gmail.com

Abstract*: The study was carried out to evaluate and access the genetic parameters and traits association for eighteen morphological traits of forty maize inbred lines planted at Melkassa Agricultural Research Center during the 2017/18 main cropping season. Grain yield showed positive and significant (p<0.01) genotypic and phenotypic association with ear diameter, leaf per plant, number of kernel row per ear, number of kernel per row, tassel length, thousand kernel weight , number of leaf per plant, thousand kernel weight, tassel length. path coefficient analysis at phenotypic level revealed that the highest positive direct effect on grain yield was exhibited by number leaf per pant (0.361) followed by tassel length (0.308), Thousand kernel weight (0.238), number of kernel row per ear (0.150), number of kernel per row(0.131) and plant height (0.075). These positive direct effects indicate that given other characters are kept constant, increasing one of these characters will increase seed yield which implies that these characters are the major contributors for the improvement of grain yield at genotypic level. However, the traits such leaf length (-0.065), Ear diameter (-0.022) and node per plant (-0.026) had negative direct effect on the grain yield per plant. The genotypic path analysis showed direct effect on grain yield was observed in leaf per plant (0.42), tassel length (0.319) and No. of kernel row per ear (0.145), thousand kernel weight (0.13) and minimum positive direct effect to the grain yield was No. of kernel per row (0.071), and Ear diameter (0.05). Therefore, these traits are more important than other traits for the genetic improvement of maize for yield.

***Keywords:* correlation, path analysis, *Zea mays* L.**

1. INTRODUCTION

Maize (Zea mays L.) is belongs to the tribe *Maydeae*, of the grass family, *poaceae* (Piperno and Flannery, 2001), Globally it is the third important cereal crop after wheat and rice. In Ethiopia it ranks first in total production and second after *teff* in area coverage (CSA, 2016/17). Maize is consumed as a staple food in different forms, including: injera (alone or mixed with teff), porridge, bread, grits and *nefro.* It is also consumed roasted or boiled (especially at green stage). Moreover, it is brewed into *tella*, *araki* and other local spirits Berhanu et al., (2007). 75% percent of Ethiopia's landmass is categorized as dryland, 45 to 120 days of growing season per year Inhabited by one third of the total populations (Kidane *et al*., 2010).

In the drought stressed areas of Ethiopia, which cover about half (46) % the total arable land and also drought stressed areas devoted to maize production occupy 38-42% of the maize growing area contributes 20% of the total maize production of the country (Mandefro *et al*, 1999). Maize grain yield is being a polygenic complex inherited character which is influenced by a number of yield contributing traits. So, the selection for desirable types should not only be based on yield, but also other yield related traits (Shengu and Tilahun, 2016).

Correlation analysis study was important to early simultaneous selection when more than one trait is desired (Kurek *et al.*, 2001) while The path analysis provides a detailed reliable statistical result for the direct and indirect effects on grain yield and justifies the existence of positive and negative correlations, high and low magnitudes among the studied traits (Silva *et al.*, 2005). There for the objective of the study was to determine the correlative relationship as well as the direct and indirect effects between grain yield and morphological traits.

2. MATERIALS AND METHODS

2.1 Description of the study area

The experiment was conducted in the 2017 main cropping season at Melkassa Agricultural Research Center (MARC) which is sub center of the Ethiopian Institute of Agricultural Research (EIAR). The center is located at $8^0$24' N latitude and $39^0$21' E longitude and an altitude of 1550 m.a.s.l.

2.2 Experimental Materials and Procedures

The 40 inbred lines were planted at Melkasa Agricultural Research Center using alpha lattice (0, 1) design (Patterson and Williams, 1976) with two replications. The genotypes were assigned at random to each experimental unit in each block. Each replicate consisted of 10 incomplete blocks and 4 plots in each blocks. The plot length was four (4) meters and 75cm space between rows with in 25cm spacing seeds were planted per hill in two rows per plot, thinning was done at the three to five leave stages to attain a final plant density of 53,333 plants/ha. All management practices including planting, fertilization, weeding and harvesting was performed as per the recommendations for the location.

2.3 Data Collection

Ten plants were selected randomly for recording observations of all the quantitative traits except for days to 50 % tasseling and silking. Mean of ten plants for each entry in each replication was worked out for each trait and used for statistical analysis.

2.4 Statistical Analysis

ANOVA was carried out for all the traits as per the procedure outlined by Gomez and Gomez, 1984 using SAS statistical software (9.2) (SAS, 2008). The linear model of observations in alpha design form:

$y_{ijk} = \mu + t_i + r_j + b_{jk} + e_{ijk}$ where yijk denotes the value of the observed trait for i^{th} treatment received in the k^{th} block within j-the replicate (super block), ti is the fixed effect of the i^{th} treatment (i = 1,2,…,t); rj is the effect of the j^{th} replicate (super block) (j = 1,2,…,r); bjk is the effect of the k^{th} incomplete block within the j^{th} replicate (k = 1,2,…s) and eijk is an experimental error associated with the observation of the i^{th} treatment in the k^{th} incomplete block within the j^{th} complete replicate.

The correlation coefficients were calculated to determine the degree of association of characters with yield and among themselves. Estimation of genotypic and phenotypic correlation coefficients was done based on the procedure of Dabholkar (1992).

Genotypic correlation coefficient (rg) = $COV_g(xy) / \sigma_g(x) * \sigma_g(y)$

Phenotypic correlation coefficient (rph) = $COV_{ph}(xy) / \sigma_{ph}(x) * \sigma_{ph}(y)$

Where, COVg (xy) and COVph (xy) are the genotypic and phenotypic covariance of two variables (X and Y), respectively, while σg (x) and σg (y) are the genotypic standard deviations for variables X and Y, respectively, and. σph (x) and σph (y) are the phenotypic standard deviations of variables X and Y, respectively.

The calculated phenotypic correlation value was tested for its significance using t-test: $t = r_{ph}/SE(r_{ph})$, Where, rph = Phenotypic correlation; SE (rph) = Standard error of phenotypic correlation obtained using the following formula (Sharma, 1998).

$SE(r_{ph}) = \sqrt{(1-r^2_{ph})/(n-2)}$

International Journal of Novel Research in Life Sciences
Vol. 7, Issue 2, pp: (1-9), Month: March - April 2020, Available at: www.noveltyjournals.com

Where, n is the number of genotypes tested, rph is phenotypic correlation coefficient.

The coefficients of correlations at genotypic levels were tested for their significance by the formula described by Robertson (1959) as indicated below:

$t = rgxy/SErgxy$ The calculated "t" value was compared with the tabulated "t" value at (n-2) degree of freedom at 5% level of significance.

Where n is the number of genotypes.

$SErgxy = \sqrt{(1-r^2gxy)\ 2/2h^2x.h^2y}$ .Where, h^2x = Heritability of trait xh^2y = Heritability of trait y

Path analysis was used for exhibiting the direct and indirect effects on seed yield according to the method suggested by Dewey and Lu (1959)

$rij = Pij + \Sigma rikpkj$ .Where, rij = mutual association between the independent character (i) and dependent character (j) as measured by the genotypic (Phenotypic) correlation coefficients. Pij = direct effects of the independent character (i) on the dependent variable (j) as measured by the genotypic (phenotypic) path coefficients, and Σrikpkj = Summation of components of indirect effects of a given independent character (i) on a given dependent character (j) via all other independent characters (k).The residual effect (p^2R) was estimated using the formula;

$\sqrt{1-R^2}$ Where, R^2□□□$pijrijp^2$

3. RESULTS AND DISCUSSION

3.1. Correlations of Yield and Yield Related Traits

Correlation among yield and yield components and other quantitative traits help to identify genotypes for futures plant breeding selection program. Correlation among yield related traits are show in (Table1).Traits like, plant height was significant and positively correlated with grain yield at phenotypic level. Number of leaves per plant was highly significant and positively correlated with grain yield both at phenotypic level and genotypic level.

Similarly Akeel *et al.* (2010) reported that At phenotypic level, leaf length (rp=0.321) were exhibited positive and significant correlation with grain yield. Ear diameter had highly significant and positive correlation with grain yield at phenotypic level and significant at genotypic level. Leaf length showed significant and positive correlation with grain yield at phenotypic level (rp=0.27).

Number of nodes per plant had significant and positive correlation with grain yield at phenotypic level (rp=0.26). Tassel length revealed highly significant and positive correlation with grain yield at phenotypic level and significant and positive correlation with grain yield at genotypic level. (rp=0.35, rg=0.37).Number of kernels row per ear had highly significant and positively correlation with grain yield.at phenotypic and at genotypic level (rp=0.32and, rg=0.36) respectively. Number of kernels per row highly significant and positively correlated with grain yield at phenotypic and significant and positive at genotypic level (rp=0.34and, rg=0.36) respectively.

Grain yield per plant was positively correlated with 100-seed weight, ear length, number of kernels per row, plant height, number of kernel rows per ear.(Reddy *et al.* 2012).

Similarly, Maize *et al.* (2008) found that grain yield was in the strongest relation with kernel row number . So results could help the breeder to select high grain yield through selection for one or more of these traits. This result indicates that selection for more kernels per row may be accompanied by increasing grain yield of maize. Thousand kernel weight depicted highly significant and positively correlated with grain yield at phenotypic and significant and positive at genotypic level (rp=0.38and, rg=0.38) respectively.

The positive associations of the above mentioned traits with grain yield indicated that these traits are the most important ones to be considered for indirect selection to improve grain yield, because grain yield can be simultaneously improved with a trait for which it showed strong relationship. This findings agree with the study recorded significant positive phenotypic correlation between grain yield and plant height (Pavan *et al.*, 2011).

Amini *et al*. (2013) showed that the value of genotypic correlation between traits were greater than phenotypic value which shows strong correlation between inherent traits. The low phenotypic correlation could arise due to the modifying effect of environment on the association traits at genetic level.. Similarly, Kinfe *et al.* (2015b) significant positive phenotypic correlation between grain yield and plant height, ear height, ear length, number of ears per plant, ear length. On the other hand Shakoor *et al*. (2007) days to tasseling and days to silking have positive and significant correlation with grain yield which is contrary to the present study..

3.2. Correlation among yield components

Days to anthesis showed highly significant positive correlation with days to silking (rp=0.91,rg=0.94), leaf per plant (rp=0.41, rg=0.5) , at phenotypic and genotypic level respectively and highly significant positively associated with tassel length at phenotypic and highly significant negatively correlated at genotypic level (rp=-0.56, rg= -0.5) and highly significant positive correlation with ear height at phenotypic level and significant positive genotypic level (rp=0.33, rg=0.38) respectively. Number of kernel per row was significantly negatively correlated at genotypic level (rg=-0.38). Similar report was done by (Kinfe *et al.*, 2015b).

Days to silking was showed highly significant positive correlation with leaves per plant at phenotypic and genotypic level respectively and significant positive correlation to ear height (rp=0.27) at phenotypic level. Similarly, Shakoor *et al*. (2007) reported that days to 50% silking was positively correlated with ear height, in contrast Bekele and Rao (2014) reported that days of 50% silking was negatively and significantly correlated with grain yield ,at genetic level and phenotypic level..

Days to maturity highly significant and positively correlated with number of kernel rows per ear at genotypic level (rg=0.00). This result was agree with Devi *et al.* (2013), so trait is while making selection for improvement in grain yield. Plant height was highly significant and had positive correlation with ear height (rp=0.61,rg=0.62), and nodes per plant (rp= 0.42,rg=0.61) at phenotypic and genotypic level respectively. It also revealed significant and positive correlation with number of leaves per plant (rp=0.27, rg=0.33), and leaf width manifested highly significant and positive correlation with plant height at Phenotypic level but significantly correlated at genotypic level (rp=0.34, rg=0.32) respectively. Similarly, Plant height was significantly and positively correlated with ear height (Akeel *et al.*, 2010,, Poudel *et al*., 2015) for grain yield per hectare (rp=0.24).

Ear height showed highly significant and positive correlation with Plant height (rp=0.61,rg=0.62), leaf number of plant (rp=0.53, rg=0.57), leaf width (rp=0.42, rg=0.44),node per plant (rp=0.63,rg=0.45), and days to 50% anthesis highly significant at phenotypic level but significant genotypic level. (rp= 0.33,rg=0.38). There was also Significant positive correlation ear height with days to 50 % silking (rp=0.27, rg=0.38), at phenotypic and genotypic level respectively. Similarly, Muhammad *et al*. (2004) reported that ear height was significantly and positively correlation with grain yield ,ear length, plant height . In contrast Akeel *et al*. (2010) showed that significantly and positively phenotypic correlations of ear height with each of number of rows per ear and ear diameter.

Number of leaves per plant manifested highly significant and positive correlation with days to silking (rp=0.31,rg=0.42),days to anthesis (rp=0.41, rg0.5), ear height (rp=0.53,rg=0.57), node per plant (rp=0.48,rg=0.6), grain yield per hectare(rp=0.41,rg=0.39), and significant and positively correlated with plant height (rg=0.27, rg=033) at phenotypic and genotypic level respectively.

Ear length was highly significant and positively correlated with ear diameter (rp=0.41, rg=0.48), tassel length (rp=0.33, rg=0.41), number of kernel rows ^{1}(rp=0.54, rg=0.63) at phenotypic and genotypic level respectively. This result is in agreement with others researchers Sarker (2015) and Jayakumar *et al.* (2007) who reported significantly positive association of ear length with number of kernels per row and ear diameter.

Ear diameter revealed highly significantly and positively associated with ear length (rp=0.41, rg=0.48) number of kernel row^{-1}(rp=0.35, rg=0.42), kernel row ear^{-1}(rp=49, rg=0.62), Thousand kernel weight (rp=0.66, rg=0.67), grain yield ha^{-1} (rp=0.35, rg=0.36) both at phenotypic and genotypic level respectively. Similarly several authors who studied associations of different traits in maize reported that ear diameter was significantly positive correlated with kernels row^{-1}, grain yield (Sarker, 2015a; Jayakumar *et al.*, 2007 and Kinfe *et al.*, 2015b).

International Journal of Novel Research in Life Sciences
Vol. 7, Issue 2, pp: (1-9), Month: March - April 2020, Available at: www.noveltyjournals.com

Leaf length showed that highly significant an positively correlated with ear length (rp=0.3), tassel length rp=0.56, rg=0.73), number of kernel row^{-1} (rp=0.44, rg=0.4) at phenotypic had genotypic level respectively. The leaf width was highly significantly and positively correlated to the plant height (rp=0.34, rg=0.32), ear height (rp=0.42, rg=0.44), at phenotypic and genotypic level.Tassel length had highly significant and positively correlation with ear length(rp=0.33, rg=0,41),ear diameter (rp=0.26), leaf length (rp=0.56, rg=0.73), number of kernel row^{-1} (rp=0.38, rg=0.5), number of kernel row ear^{-1}(rp=0.27, rg-=0.41) and grain yield ha^{-1} (rp=0.35, rg=0.37) at phenotypic and genotypic level respectively. Similarly, Kumar *et al.* (2011) reported that number of branches per tassel had highly significant positive correlation with yield per plant with number of kernels per row.

Number of kernel rows per ear highly significant correlated and positively with ear diameter (rp=0.49, rg=0.62), number of kernel row^{-1} (rp=0.35, rg=0.41), tassel length (rp=0.27, rg=0.41), leaf length (rp=0.26) at phenotypic and genotypic level respectively. Also it revealed positively and significantly correlation with grain yield and number of kernel row^{-1} had significant and positive correlation with grain yield ha^{-1} (rp=0.36, rg=0.36). Similarly, (Srećkov *et al.*, 2010 ; Sarker, 2015 and poudel *et al.*, 2015) grain yield had in the strongest relation with kernel row number. Thousand kernel weight had significant and positive correlation with ear length phenotypically (rp=0.23) and grain yield ha^{-1} (rp=0.38, rg=0.38) phenotypic and genotypic level respectively.

4. PATH ANALYSIS OF GRAIN YIELD AND OTHER TRAITS

Phenotypic and genotypic correlations were analyzed by path coefficient analysis technique, to identify the important yield attributes by estimating the direct effects of traits contributing to grain yield.

Path coefficient analysis as proposed by Dewey and Lu (1959) was utilized for partitioning the total correlation in to direct and indirect effects. As shown in Table 2, only 9 out of the 18 traits at phenotypic level and 6 out of 18 traits partitioned into direct and indirect effects using grain yield kilogram per hectare as a dependent variable.

4.1. Phenotypic direct and indirect effects of various traits on grain yield

The path coefficient analysis at phenotypic level revealed that the highest positive direct effect on grain yield was exhibited by number leaf per pant (0.361) followed by tassel length (0.308), thousand kernel weight (0.238), number of kernel rows per ear (0.150), number of kernels per row (0.131) and plant height (0.075) indicating that relationship between these traits as good contributors to grain yield, Which means positive direct effects indicate that given other characters are kept constant, increasing one of these traits will increase grain yield which implies that these traits are the major contributors for the improvement of grain yield at genotypic level. However, the traits such as leaf length (-0.065), ear diameter (-0.022) and node per plant (-0.026) had negative direct effect on the grain yield per plant. Therefore, the direct selection of these traits might be ineffective. These negative direct effects were counter balanced by the positive indirect influences of grain yield

Table 1 .Genotypic coefficient of correlation above diagonal and phenotypic coefficient of correlation below the diagonal.

Traits	DA	DS	MD	PH	EH	NLPP	EL	ED	NEPP
DA	1	0.94**	-0.38*	0.02	0.38*	0.5**	-0.35*	-0.21	-0.16
DS	0.91**	1	-0.37*	0.03	0.31	0.42**	-0.41**	-0.22	-0.15
MD	-0.36**	-0.35**	1	-0.05	-0.2	-0.32	0.1	0.01	0.06
PH	-0.03	0.002	-0.04	1	0.62**	0.33*	-0.06	-0.06	0.01
EH	0.33**	0.27*	-0.19	0.61**	1	0.57**	-0.08	-0.14	-0.02
NLPP	0.41**	0.31**	-0.27*	0.27*	0.53**	1	-0.05	0.13	-0.15
EL	-0.29**	-0.35**	0.12	0.003	-0.05	-0.04	1	0.48**	-0.49**
ED	-0.19	-0.24*	0.03	-0.01	-0.14	0.07	0.41**	1	-0.46**
NEPP	-0.09	-0.09	0.07	0.08	-0.04	-0.11	-0.28**	-0.28	1
LL	-0.28**	-0.29*	0.003	0.18	0.08	0.05	0.3**	0.11	0.05
LW	0.1	0.09	0.05	0.34**	0.42**	0.2*	0.08	0.07	-0.09
NPP	0.16	0.16	-0.08	0.42**	0.45**	0.48**	-0.09	0.08	-0.01
TL	-0.45**	-0.43**	-0.03	0.15	-0.02	-0.13	0.33**	0.26**	0.04

International Journal of Novel Research in Life Sciences
Vol. 7, Issue 2, pp: (1-9), Month: March - April 2020, Available at: www.noveltyjournals.com

NTB	-0.04	-0.00	-0.05	0.08	0.14	0.2	-0.23	0.03	0.04
NKRPE	-0.14	-0.1	0.08	0.06	-0.06	0.06	0.16*	0.49**	-0.19
NKPR	-0.33**	-0.37**	-0.01	0.18	0.1	0.07	0.54**	0.35**	-0.11
TKW	-0.21	-0.24**	0.11	0.05	-0.05	0.18	0.23*	0.66**	-0.35**
GYPH	-0.11	-0.1	-0.16	0.24*	0.13	0.39**	-0.05	0.35**	0.19

DA = Date of 50% anthesis, DS = Date of 50% slicking , DM = Date of 90% Maturity, ED = Ear diameter, EL = Ear length, , PH = Plant height, EH = ear height, ,TL = Tassel length, NLPP = Number of leaf per plant, LW = Leaf width, LL = Leaf length NKRPE = No. of kernel row per ear, TKW=thousand kernel weight, GYPH = Grain yield per hectar , NKPR = Number of kernel per row , NEPP =Number ear per plant, NPP = Node per plant , NTB = Number of tassel branch** = most significant P[≤0.01], *= significant P[≤0.05], NS = Non significant P[>0.05].

Table1.*Continues…..*

Traits	LL	LW	NPP	TL	NTB	NKRPE	NKPR	TKW	GYPH
DA	-0.33	0.16	0.2	-0.5**	-0.02	-0.19	-0.38*	-0.22*	-0.1
DS	-0.3	0.14	0.2	-0.45**	0.05	-0.01	-0.39**	-0.27**	-0.1
MD	-0.06	0.06	-0.08	-0.02	-0.09	0.00**	-0.04	0.11	-0.19
PH	0.16	0.32*	0.61**	0.21	0.04	0.16	0.15	0.01	0.3
EH	0.06	0.44**	0.63**	-0.03	0.12	0.01	0.09	-0.07	0.14
NLPP	-0.09	0.26**	0.6**	-0.19**	0.17	0.02	0.07	0.3	0.41**
EL	0.25*	0.02	-0.08	0.41**	-0.33	0.21	0.63**	0.29**	-0.03
ED	0.08	0.09	0.06	0.23	0.03	0.62**	0.42**	0.67**	0.39*
NEPP	0.01	-0.07	-0.01	0.01	0.13	-0.27	-0.18*	-0.45**	0.22
LL	1	0.08	-0.02	0.73**	0.1	0.27	0.4*	0.11	0.25
LW	0.14**	1	0.32*	0.24	0.1	0.25	0.09	-0.03	0.21
NPP	-0.02	0.19	1	-0.04	0.18	0.13	0.3	0.18	0.31
TL	0.56**	0.21*	0.02	1	-0.13	0.41**	0.5**	0.15	0.37*
NTB	0.18	0.13	0.14	-0.09	1	0.24	-0.03	-0.17	0.17
NKRPE	0.26*	0.12	0.12	0.27*	0.2*	1	0.41**	0.25	0.36*
NKPR	0.44**	0.12	0.2	0.38**	0.04	0.35**	1	0.16	0.36*
TKW	0.13	-0.02	0.13	0.14*	-0.11	0.2	0.17	1	0.38*
GYPH	0.27*	0.15	0.26*	0.35**	0.18	0.32**	0.34**	0.38**	1

DA = Date of 50% Anthesis, DS = Date of 50% slicking , DM = Date of 90% Maturity, ED = Ear diameter, EL = Ear length, , PH = Plant height, EH = Ear height, ,TL = Tassel length, NLPP = No. of leaf per plant, LW = Leaf width, LL = Leaf length NKRPE = No. of kernel row per ear, TKW=thousand kernel weight, GYPH = Grain yield per hectare , NKPR = No. of kernel per row , NEPP =No. Ear per plant, NPP = Node per plant, NTB = No. of tassel branch** = most significant p [≤0.01], * = significant P [≤0.05], NS = Non significant P [>0.05].

According to Izge *et al.* (2006) higher indirect values could most likely be neutralized in most cases by negative indirect effects via other traits and this can lead to their low and non-significant genotypic correlations with total yield. As a result, this trait will be considered as main components for selection in a breeding program for higher grain yield.

Plant height had positive direct effect and the phenotypic correlation with grain yield was significant positive. Its indirect effect via number of leaf per plant and other traits were mostly positive therefore, the positive correlation coefficient with grain yield was due to its direct and indirect effect. This is agreed with the finding of (Kassahun *et al*., 2011).

Number of leaves per plant had both the direct and indirect positive effects largely via ear diameter and leaf length outweighed for the positive correlation with grain yield (rp=0.39**). So, both direct positive and indirect positive effects were the causes of the significant correlation. Therefore, such considerable indirect effects should be considered for selection. Considerable direct effect and positive significant correlation number of leaf per plant with grain yield was reported by (Khandelwal *et al*., 2015).

Tassel length was another trait which had positive direct effect which is small as compared to its correlation coefficient. But it also contributed considerable positive indirect effect to grain yield via number of kernel rows per ear and number of kernels per row. Therefore, high positive correlation of tassel length with grain yield was due to both its positive direct effect and indirect effect via number of kernel rows per ear and number of kernel per row.

The high positive correlation of ear diameter with grain yield was mainly due to the indirect effects of leaves per plant and tassel length. Thousand Kernel weight and number of kernel row per ear and kernel per ears also showed positive direct effect.

Ear diameter, leaf length and node per plant directly negative effect, positive correlation and had positive indirect effect through, Thousand Kernel weight, tassel length and number of leaf per plant for grain yield respectively. The positive association of ear diameter and leaf length and node per plant with grain yield is mainly due to indirect effect of tassel length. However, the negative association this trait with grain yield is due to both negative direct and indirectly effects of most of the traits.

The traits that exerted positive direct effect (number of leaves per plant, tassel length, plant height and kernel rows per ear, kernel ear per row and thousand kernels weight) and their positive significant correlation coefficient with grain yield were known to affect grain yield in the favorable direction and needs much attention during the process of selection. Moreover the small indirect effects of tassel length, leaf per plant and Kernel row per ear and number of kernel per ear through other traits of should be simultaneously considered.

Table 2: Estimates of direct (bold diagonal) and indirect effect (off diagonal) at phenotypic level of nine traits on grain yield.

Variable	PH	NLPP	ED	LL	NPP	TL	NKRPE	NKPR	TKW	Rp
PH	**0.075**	0.097	0.0002	-0.012	-0.010	0.047	0.009	0.022	0.012	0.24*
NLPP	0.020	**0.361**	-0.0014	-0.003	-0.012	-0.04	0.009	0.009	0.044	0.39**
ED	-0.001	0.024	**-0.0220**	-0.007	-0.002	0.079	0.075	0.046	0.158	0.35**
LL	0.014	0.019	-0.0024	**-0.065**	0.000	0.174	0.039	0.057	0.033	0.27*
NPP	0.030	0.174	-0.0017	0.001	**-0.026**	0.007	0.018	0.026	0.032	0.26*
TL	0.011	-0.048	-0.0056	-0.037	-0.001	**0.308**	0.041	0.049	0.033	0.35**
NKRPE	0.005	0.022	-0.0110	-0.017	-0.003	0.084	**0.150**	0.046	0.048	0.32**
NKPR	0.013	0.026	-0.0076	-0.028	-0.005	0.117	0.052	**0.131**	0.04	0.34**
TKW	0.004	0.066	-0.0146	-0.009	-0.003	0.042	0.030	0.022	**0.238**	0.38**

PH = Plant height, NLPP = Number of leaf per plant, ED = Ear diameter, LL = Leaf length, NKPR = No. of kernel per row, NPP = Node per plant, TKW=thousand kernel weight, TL = Tassel length, NKRPE = Number of kernel row per ear

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

The genotypic direct and indirect effects of six yield related traits on grain yield are shown in table 7. The maximum positive genotypic direct effect on grain yield was observed in leaves per plant (0.42), tassel length (0.319) and number of kernel rows per ear (0.145), thousand kernels weight (0.13) and minimum positive direct effect to the grain yield was number of kernel per row (0.071), and ear diameter (0.05).

According to the result leaves per plant, tassel length and number of kernel rows per ear were more selective than the other because they had positive and highly significant correlation with grain yield. Indicating selection based on these traits would be effective for enhancing the grain yield of the genotypes. Leaves per plant in addition to it had positive and highly significant correlation with grain yield per hectare, it also had positive direct effect and positive indirect effect through tassel length, leaves per plant, number of kernels per row, number of kernel rows per ear and ear diameter.

Table 3: Estimates of Direct (bold diagonal) and Indirect effect (off diagonal) at genotypic level.

Variable	NLPP	ED	TL	NKRPE	NKPR	TKW	Rg
NLPP	**0.42**	0.01	-0.059	0.002	0.005	0.04	0.41**
ED	0.05	**0.05**	0.075	0.090	0.030	0.09	0.38*
TL	-0.08	0.01	**0.319**	0.060	0.035	0.02	0.37*
NKRPE	0.01	0.03	0.131	**0.145**	0.029	0.03	0.38*
NKPR	0.03	0.02	0.155	0.060	**0.071**	0.02	0.36*
TKW	0.12	0.03	0.047	0.037	0.011	**0.13**	0.38*

Number of leaves per plant, ear diameter, number of kernels per row and thousand kernels weight had direct, significant and high positive correlation (0.41), (0.38), (0.38) and (0.38) respectively with grain yield. Therefore, simultaneous selection through these traits will be effective for grain yield improvement. Considerable direct effect and positive significant correlation of thousand kernel weight with grain yield was reported by (Khandelwal *et al*., 2015; Silva *et al*., 2017).

REFERENCES

[1] Amini, Z., Khodambashi, M and Houshmand, S. 2013. Correlation and Path Coefficient Analysis of Seed Yield Related Traits in Maize', *International Journal of Agriculture and Crop Sciences.* (d) : 2217–2220.

[2] Akeel, A., Azzam, H.K and Ahmad, S.A.A. 2010. Genetic variances, heritability correlation and path coefficient analysis in yellow maize crosses (*Zea mays* L.) *Agriculture and Biology Journal of North America* (1975),1(4): 630-637

[3] Bekele, A. and Rao, T. N. 2014. Estimates of heritability, genetic advance and correlation study for yield and it's attributes in maize (*Zea mays* L .)', *Journal of Plant Sciences*, 2(1): 1–4. doi: 10.11648/j.jps.20140201.11.

[4] Berhanu , Fernandez, R. S., Mohammed, H., Mwangi, W. and Seid Ahmed.,2007. Maize and livestock: Their inter-linked roles in meeting human needs in Ethiopia. Research Report 6. ILRI (International Livestock Research Institute), Nairobi, Kenya. 103 .

[5] CSA. 2017. Agricultural sample Survey of 2016/2017. Report on area and production of major crops. Statistical bulletin, Addis Ababa, Ethiopia.

[6] Dabholkar AR (1992) Elements of biometrical genetics. Concept Publishing Company, New Delhi, India.

[7] Devi,H.N., N. Brajendra Singh,T. Ratan Singh,N. Jyotsna and Amitava Paul. 2013. Phenotypic Characterization, Genetic Variability and Correlation Studies among Maize Landraces of Manipur, *International Journal of Bio-resource and Stress Management*, 4(2): 352–355.

[8] Dewey, D.R. and K.H. LU., 1959. A correlation and path coefficient analysis of components of crested wheat grass seed production. *Agronomy Journal*. 51: 515-518.

[9] Dewey, D.R. and Lu, K.H. 1959. A correlation and path coefficient analysis of components of crested wheat grass seed production Agronomy Journal science .51: 515-518.

[10] FAOSTAT. 2018. Food and Agriculture organization statistics. http://faostat.fao.org. Accessed in 2018.

[11] Gomez KA, Gomez AA. 1984. Statistical procedures for agricultural research. 2nd ed. Chichester, UK: Wiley.

[12] Izge AU, Kadams AM, Gungula DT. 2006. Studies on Character Association and path analysis of certain quantitative characters among parental lines of pearl millet (Pennisetum glaucum) and their F1 hybrids in a diallel cross. *Africa Journal Agricultural Research*. 1(5): 194-196.

[13] Jayakumar, J., T. Sundaram, D. Arun Prabu and A. Ragu Rama Rajan.2007. Correlation studies in maize (Zea mays L.) evaluated for grain yield and other yield attributes', *International Journal of Agricultural Sciences*, 3(2): 57–60.

[14] Kassahun Amare, Habtamu Zeleke and Geremew Bultosa. 2011. Variability for yield, yield related traits, protein Content and association among traits of sorghum [Sorghum bicolor (L) Moench] Varieties in Wollo, Ethiopia. *Journal of Plant Breeding and Crop science*, 125-133.

[15] Khandelwal, V., Shukla, M., Jodha, B. S., Nathawat, V. S. and Dashora, S. K. 2015. Genetic Parameters and Character Association in Sorghum [Sorghum bicolor (L.) Moenc]). *Indian Journal of Science and Technology*, 8(22).

[16] Kidane G. 2010. Agricultural based Livelihood Systems in Dry lands in the Context of Climate Change Inventory of Adaptation Practices and Technologies of Ethiopia

International Journal of Novel Research in Life Sciences
Vol. 7, Issue 2, pp: (1-9), Month: March - April 2020, Available at: www.noveltyjournals.com

[17] Kinfe Hailegebrial, Getachew, A., Legesse, W. and Yemane, T. 2015. Correlation and Path Coefficient Analysis of Grain Yield and Yield Related Traits in Maize (*Zea mays* L.) Hybrids at Bako, Ethiopia. *Journal of Biology, Agriculture and Healthcare, 5(15):3195-3208.*

[18] Kumar, T.S.D Mohan Reddy K.Hariprasad Reddy and P.Sudhakar.2011. Targeting of traits through assessment of interrelationship and path analysis between yield and yield components for grain yield improvement in single cross hybrids of maize(*Zea mays* L .)', *International Journal of Applied Biology and Pharmaceutical Technology*, 2(3): 123–129. Available at: www.ijabpt.com.

[19] KUREK, A. J. et al. Análise de trilha como critério de seleção indireta para rendimento de grãos em feijão. Revista Brasileira de Agrociência, v. 7, n. 1, p. 29-32, 2001.

[20] Maize, T., Alake, C O Ojo, D KOduwaye, O.A Adekoya, M A .2008. 'Genetic Variability and Correlation Studies in Yield and Yield Related characters of', *ASSET International Journal*: 8, 14–27.

[21] Muhammad Rafique, Amer Hussain, Tariq Mahmood, A.W.A.A. M. B.A. A.2004. 'Heritability and Interrelationships Among Grain Yield and Yield Components in Maize (*Zea mays* L).', *International Journal of Agriculture & Biology,* 6(6): 1113–1114.

[22] Pavan R, Lohithaswa W, Shekara. 2011. Correlation and path coefficient analysis of grain yield and yield contributing traits in single cross hybrids of maize (*Zea mays* L.). *Electronic Journal of Plant Breeding*. 2:253-257

[23] Piperno, d.r. & Flannery, K.V. 2001. The earliest archaeological maize (*Zea mays* L.) from highland Mexico: new accelerator mass spectrometry dates and their implications. Proceedings of National Academy of Sciences, 98, 2101-2103.

[24] Piperno, d.r. & Flannery, K.V. 2001. The earliest archaeological maize (*Zea mays* L.) from highland Mexico: new accelerator mass spectrometry dates and their implications. Proceedings of National Academy of Sciences, 98, 2101-2103.

[25] Poudel, M., Paudel, H. K. and Yadav, B. P. 2015. Correlation of traits affecting grain yield in winter maize (Zea mays L.) genotypes', *International Journal Applied Sciences and Biotechnology*, 3(3): 443–445. doi: 10.3126/ijasbt.v3i3.13137.

[26] Reddy, V.R., Farzana Jabeen, M.R.Sudarshan and A.Seshagiri Rao. 2012. 'Studies on Genetic Variability, Heritability, Correlation and Path Analysis in Maize (*Zea mays* L .) over locations Principal Scientists,Acharya N.G.Ranga Agricultural University , Rajendranagar,Hyderabad-30',International Journal of Applied biology and harmaceutical Technology: 195–199.

[27] Sarkar, A. 2015a. Stability analysis for yield and related traits in maize (*Zea mays* L.) hybrids grown under different moisture regimes in terai region of West Bengal', Journal of Crop and Weed, 11(Special Issue): 11,38–43.

[28] Shakoor, M. S., Akbar, M. and Hussain, A. 2007. 'Correlation and Path Coefficients Studies of some', Pakistan Journal Agricultural Sciences, 44(2): 213–216.

[29] Sharma,J.R.1998.Statisticalandbiometrical techniques in plant breeding. New AgeInternational(P) Limitted Publishers, New Delhi, 432.

[30] Shengu, M.K. and Tilahun, B. 2016. Heritability and Performance of Single Cross Maize Hybrids in Dilla and Abaya Areas, III (Vii): 1–5.

[31] Silva SDA, Sereno MJCM, Silva CFL, Oliveira AC and BarbosaNeto JF (2005) Genetic parameters and QTL for tolerance to flooded soils in maize. Crop Breeding and Applied Biotechnology 5: 287-293.

[32] Silva, K.J., Teodoro, P.E., Menezes, C.B and De Júlio, M.P.M. 2017.Contribution of morph agronomic traits to grain yield and earliness in grain sorghum, Journal of Genetics and Molecular Research, 16(2):

[33] Srećkov,Z.Bocanshi,Aleksandra,Nastasic,Ivica,Đalovic,Mirjana,Vukosavljev.2010. Correlation and Path Coefficient Analysis of Morphological Traits of Maize (*Zea mays* L.)', Research Journal of Agricultural Science, 42(2): 292–296.