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Studying Correlation in Early Maturing Maize (*Zea Mays*) Inbred Lines in Central Rift valley of Ethiopia

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Abstract- **This work was executed to estimate correlation among yield and yield related traits in early maturing maize inbred lines. Hence, fifteen inbred lines were crossed in a diallel mating system. Two standard checks along with one candidate variety and hybrids were evaluated in Alpha Lattice Design with two replications at Melkassa Research Center. Grain yield showed positive and highly significant correlations with plant height, ear height, ear per plant, ear length, ear diameter, number of kernels per row, number of kernels per ear and thousand kernel weights at phenotypic and genotypic levels. This suggests that grain yield could simultaneously be improved by selecting for these traits. In general, this study identified inbred lines and hybrid associations that had desirable expression of important traits. This will be useful for the selection of high yielding and early maturing hybrids for all locations.**

Index Terms— **Correlation, maize inbred lines, early maturing, Melkassa**

I. Introduction

Maize is one of the most important crops in the world. It is used as a human food, livestock feed, different alcoholic and none alcohol drinks production, building material, and as fuel. It is also used to produce medicinal products such as glucose as well as an ornamental plant [1].

In the country, 2,152,858.24 hectares of land was covered with maize with an estimated production of about 5,565,736.066 tons [2]. However, the national average yields 2.54Mt/ha [2] is still far below the world average 5.12Mt/ha, [3]. Such low grain yield of maize is attributable to lack of improved varieties for different agro-ecological regions, diseases and insect pests, moisture stress, poor cultural practices, excessive plant height and low soil fertility [1].

One of the important strategies plant breeders adopted to overcome the problem of getting a better yield is to select germplasms that used to identify high yielding genotypes that may give a reasonable yield on different soil and environmental conditions [4].

The reason for selecting early maturing maize inbred lines is that no work has been done for understanding and describing the nature and extent of genotypic and phenotypic association as well as correlation and association between yield and yield components of early maturing maize inbred lines in Central Rift valley of Ethiopia so far. Information on association of locally available and introduced early maturing elite maize inbred lines is very important for future development strategies for drought stress areas of Ethiopia. Therefore, the current study is designed to estimate correlation among yield and yield related traits; and to work out direct and indirect effects of these traits on grain yield by path coefficient analysis in drought stress areas.

II. MATERIALS AND METHODS

The experimental materials used for the current experiment consisted of a total of 108 entries which comprised of 105 single crosses developed from 15x 15 diallel crosses (excluding the reciprocal crosses and parents) inbred lines, along with two standard checks; namely, Melkassa-2; BH-543 and one elite variety Melkassa hybrid-130.The experiment was laid out in 9 x 12 alpha-lattice designs[5] with two replications at Melkassa Research Center during 2011, cropping season. Fifteen inbred lines were crossed in a diallel fashion and 105 different crosses along with two checks and one elite variety were included for association studies.

The parental lines were originally obtained from CIMMYT and selected for per se performance across drought stressed environments in Central Rift Valley of Ethiopia. The checks were excluded from the genetic analysis. The net plot size was 4.25m x 0.75m =3.2m2. Planting was done by hand on June 27, 2011. Two seeds were sown per hill which later thinned to one plant per hill after seedlings established well to get a total plant population of 53,333 per ha. 100 DAP and 50 Urea kg per hectare were applied uniformly for each location. DAP was applied at planting while whole Urea was applied at knee height stage of the crop. All other recommended crop management practices were applied uniformly.

Data were recorded on plot and single plant basis for the following parameters to represent their respective characters.

Data Collected on plot bases: days to emergence, days to anthesis, days to silking, anthesis–silking interval, ears per plant, days to maturity and thousand kernel weights.

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Data recorded using random sample of 5 plants or ears from each plot. plant height, ear height, number of ears per plant, ear length, ear diameter, number of kernel rows per row, number of kernels per row, number of kernels per. Data analysis: the data were analyzed for combining ability using [6].

III. RESULTS AND DISCUSION

Correlation analysis

The estimates of phenotypic associations for grain yield and yield related traits were presented in (Table 1). Grain yield showed positive and significant phenotypic associations with most of the traits studied. In line with the current study, [7] found positive and significant correlations of grain yield with number of kernels per row, ear length and thousand kernel weights. [7] also found positive and significant correlations of grain yield with ear diameter, number of kernels per row, thousand kernel weight and plant height. [8] reported similar results with ear diameter, ear length and thousand kernel weights. Similar to the current study, [9] found positive and significant correlation of grain yield with plant height. [10] found positive and significant correlations of grain yield with plant height, ear height and number of kernels per row that agrees with the present study. [11] also found positive and significant correlation of grain yield with ear height which accorded with the current study.

Similarly, [12] also reported positive and significant associations of grain yield with ear height, plant height, ear length, ear diameter, number of kernels per row and thousand kernel weights. [13] also found positive and highly significant phenotypic correlations between grain yield and plant height, ear height, ear length, ear length, number of kernels per row and thousand kernels weight. [14] found positive and highly significant correlations of grain yield with plant height, ear height, ear per plant, ear length, ear diameter, and number of kernels per row, number of kernels per ear and thousand kernel weight which accorded with the current study.

Hence, 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, as grain yield can be simultaneously improved with a trait for which it showed strong relationship.In contrary, grain yield showed negative and significant correlations with days to anthesis (rp=-0.19**), days to silking (rp=0.21**), and anthesis silking interval (rp=-0.11**), depicting genotypes with longer anthesis-silking interval and earlier in maturity period would result in reduced grain yield and susceptible to disease. In line with this study, [15] observed negative and significant phenotypic correlation between grain yield and days to anthesis. Similarly, [12] reported negative and significant association between yield and days to silking. In addition, grain yield showed non-significant phenotypic correlation with days to maturity and number of rows per ear; showing that selection for increased level of these traits may not bring significant change in grain yield.

On the other hand, [13] found positive and significant phenotypic correlations between grain yield with days to silking and days to anthesis. [12] also found positive and significant correlation of grain yield with days to maturity. In contrast to findings of the current study, [2] positive and significant correlation of grain yield with days to maturity. [9] found non-significant correlation of grain yield with ear height [10] found positive and significant correlation of grain yield with days to silking and days to maturity.

Days to anthesis showed positive and highly significant phenotypic associations with days to silking (rp=0.99**), days to maturity (rp=0.45**) and number of rows per ear (rp=0.14**) whereas negative and significant associations were observed between days to anthesis silking interval, ear per plant, ear length and thousand kernel weights.

In line with the current study, [14] found negative and significant associations between days to anthesis with anthesis –silking interval and thousand kernel weight. In contrast to the current study, [16] found positive and significant association between days to anthesis and plant height. Days to silking showed positive and significant associations with days to maturity, number of rows per ear and number of kernels per ear but negative and significant associations with ear per plant, ear length and thousand kernel weight.

Anthesis-silking interval indicated positive and significant associations with ear per plant (rp=0.02**) whereas negative and highly significant with ear height (rp=-0.15**). In contrast to the current study, [14] reported positive and significant associations between days to anthesis and ear height. Plant height showed positive and significant associations with ear height (rp=0.12**), ear per plant (rp=0.10**), ear length (rp=0.12**), and ear diameter (rp=0.08*). Similarly, [2], [9], [16] and [14] reported positive and significant association between plant height and ear height. The positive correlations of plant height and ear height with many other traits mentioned above indicated the possibility to improve these traits simultaneously; that is improvement in plant height and ear height could improve all the positively correlated traits.

Ear height showed positive and significant associations with thousand kernel weight (rp=0.13**) whereas negative and significant associations with ear diameter (rp=-0.11**). Ear per plant showed positive and significant associations with ear length (rp=0.12**) while negative and significant associations with days to maturity (-0.10**).

Ear length showed positive and significant associations with ear diameter (rp=- 0.45**), number of kernels per row (rp= 0.60**) and number of kernels per ear (rp=0.08**). Ear diameter showed positive and significant associations with number of kernels per row (rp= 0.28**), number of rows per ear (rp=0.39**) and number of kernels per ear (rp=0.46**). Similarly, [14] found positive and significant associations of ear length and ear diameter with number of kernels per row.

Number of kernel per row showed positive and significant associations with kernels per ear (rp=0.76**). Number of rows per ear showed positive and significant associations with number of kernels per ear (rp=0.69**) whereas negative and significant with thousand kernels weight (rp= -p0.14**).

At genotypic level grain yield showed positive and highly significant correlations with most of the traits studied while negative and highly significant association were recorded for grain yield with anthesis silking interval.

Similarly, [10] indicated positive and significant associations of grain yield with plant height, ear height and number of kernels per row. [17] also found positive and significant associations of grain yield with number of kernels per row and plant height. [9] found similar result of strong correlation between grain yield and plant height [12] reported positive and highly significant genotypic associations of grain yield with plant height, ear length and number of kernels per row. [14] also found positive and significant associations of grain yield with plant height, ear height, ear length, ear diameter and number of kernels per row. Similar to this study, [10] reported positive and significant correlations of grain yield with days to anthesis and days to days to maturity. [17] also reported positive and significant associations of grain yield with days to anthesis, thousand kernels weight and days to maturity.

Days to anthesis and days to silking showed positive and significant associations with plant height, ear height, days to maturity, ear length, ear diameter, number of kernels per row, number of rows per ear and number of kernels per ear. Positive and highly significant correlations were observed between days to anthesis and days to silking. In line with this study, [10] reported strong genotypic correlation (rg=0.94**) between days to anthesis and silking. Anthesis silking interval showed negative and highly significant with ear height and days to maturity. Similarly, [9] showed positive and significant association of anthesis silking interval with ear height.

Plant height showed positive and highly significant associations with ear height (rg=0.24**), ear length (rg=0.27**), ear diameter (rg=0.25**), number of kernels per row (rg= 0.31**), number of rows per ear (rg=0.32**) and number of kernels per ear (rg=0.40**). In line with the current study, [9] and [12] reported positive and significant associations between plant height and ear height at genotypic level. [14] reported positive and significant associations of plant height with ear height, ear length and number of kernels per row. Similar to the current study, [17] reported positive and significant associations of plant height with ear diameter.

The positive and significant associations between ear height and plant height indicate the possibility to improve these two traits simultaneously. In other expression, by selecting for shorter plant height we can also select varieties with shorter ear height and this can in turn help us to obtain lodging tolerant varieties especially in high rainfall areas where lodging problem is prevalent.

Ear height showed positive and highly significant associations with days to maturity (rg= 0.40**), ear length (rg= 0.36**), number of kernels per row (rg=0.30**) and number of kernels per ear (rg= 0.19*). In agreement to the current study, [14] also found positive and significant associations of ear height with ear length. Days to maturity showed positive and significant associations with ear length (rg= 0.31**).

Ear length, ear diameter, number of kernels per row and number of rows per ear showed positive and significant associations with number of kernels per ear. Ear length and ear diameter showed positive and significant associations with number of kernels per row. Ear length showed positive and significant associations with ear diameter. Number of kernels per showed positive and significant with number of rows per ear. Number of rows per ear kernels per row, number of rows per ear and number of kernels per ear showed negative and significant with thousand kernel weight.

Table 1. Estimates of correlation coefficients at Phenotypic (below diagonal) and genotypic (above diagonal) levels among 15 traits in diallel hybrids of elite early maturing maize inbred lines at three locations.

Variable	GY	DA	DS	ASI	PH	EH	EPP	DM	EL	ED	KPR	RPE	KPE	TKW
GY		0.31**	0.28	-0.25**	0.22*	0.45**	0.47**	0.37**	0.50**	0.43**	0.36**	0.22*	0.35**	-0.11**
DA	-0.19**		0.99**	-0.24**	0.37**	0.56**	0.11	0.44**	0.31**	0.24**	0.42**	0.35**	0.45**	-0.23*
DS	-0.21**	0.99**		-0.10	0.37**	0.54**	0.10	0.42**	0.30**	0.22*	0.43**	0.36**	0.46**	-0.22*
ASI	-0.11**	-0.20**	-0.04		-0.11	-0.27**	-0.10	-0.20*	-0.12	-0.17	-0.02	-0.03	-0.02	0.05
PH	0.18**	-0.06	-0.06	0.02		0.24**	0.13	0.17	0.27**	0.25**	0.31**	0.32**	0.40**	-0.13
EH	0.37**	0.07	0.05	-0.15**	0.12**		0.16	0.40**	0.36**	0.12	0.30**	0.06	0.19*	-0.07
EPP	0.33**	-0.13**	-0.13**	0.02**	0.10**	-0.03		0.04	0.08	0.05	0.13	0.07	0.11	-0.16
DM	-0.07	0.45**	0.45**	-0.07	-0.03	0.03	-0.10**		0.31**	0.18	0.15	0.03	0.10	0.01
EL	0.28**	-0.13**	-0.12**	0.06	0.12**	0.02	0.12**	-0.01		0.41**	0.49**	0.06	0.30**	0.06
ED	0.21**	-0.06	-0.05	0.02	0.09*	-0.11**	0.07	0.03	0.45**		0.29**	0.54**	0.54**	0.01
KPR	0.22**	-0.01	-0.01	0.03	0.06	0.04	0.08	-0.03	0.60**	0.28**		0.31**	0.76**	-0.19*
RPE	0.06	0.14**	0.14**	0.02	0.03	0.02	-0.02	0.06	-0.02	0.39**	0.06		0.85**	-0.26**
KPE	0.20**	0.07	0.08*	0.04	0.06	0.04	0.04	0.01	0.42**	0.46**	0.76**	0.69**		-0.28**
TKW	0.14**	-0.24**	-0.25**	0.01	0.04	0.13**	-0.01	-0.07	0.08*	0.07	0.02	-0.14**		

GY= grain yield, DA=days to maturity, DS=days to silking, ASI=anthesis silking interval, PH=plant height, EH=ear height, EPP=ear per plant, DM=days to maturity, EL=ear length, ED=ear diameter, KPR=number of kernels per row, RPE=number of rows per ear, KPE=number of kernels per ear and TKW=thousand kernel weights.

IV. CONCLUSION

Positive and significant phenotypic and genotypic associations were showed for most traits study. Traits having strong relationship with grain yield can be used for indirect selection to improve grain yield because it can be simultaneously improved along with the traits for which it showed strong relationship.

In contrary, grain yield was negative with days to anthesis, days to silking, anthesis silking interval, days to maturity, and number of rows per ear exerted positive direct effects on grain yield and also correlated positively and significantly with grain yield.

V. RECOMMENDATION

Generally, the results of the current study identified that inbred lines with positive direct effects on grain yield also correlated positively and significant with grain yield at both genotypic and phenotypic levels. Hence, the information from this study may possibly be useful for researchers who would like to develop high yielding varieties of maize by identifying its direct and indirect effects on grain yield.

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