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Genetic Study of Some Maize (Zea Mays L) Genotypes in Humid Tropic of Ethiopia

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Abstract- The current study was initiated to find out the nature and magnitude of genetic variability for different traits in 12 maize genotypes using randomized complete block designs in humid tropics of Ethiopia in 2015. Analysis of variance showed that the mean squares due to genotype were significant at ($p<0.01$) for maturity traits, plant and ear height, number of row per ear, thousand kernel weights and grain yield per hectare, indicating the existence of sufficient genetic variability and the potential for selection and improvement of the traits. High phenotypic and genotypic coefficients of variations were obtained from number of ear per plant, ear diameter, grain yield per hectare, number of row per ear and ear length, indicating less environmental influence on the traits. High heritability estimates were obtained from all traits except anthesis-silking interval depicting the traits respond positively due to selection. Estimates of genetic advances as percent of mean at 5% selection intensity ranged from 4.68% for 1000-kernel weights to 78.95% for number of ear per plant.

Index Terms- Genetic advance, Genetic variability, Heritability, Maize

I. Introduction

Maize is one of the most important cereal crops in the world. It is used as a human food and livestock feed. Moreover it is used to produce different alcoholic and non-alcoholic drinks, construction materials and fuel. It is also used to produce medicinal products such as glucose and used as ornamental plant [1]. Maize was introduced to Ethiopia by the Portuguese in the 16^{th} or 17^{th} century [2]. Since its introduction, it has gained importance as a main food and feed crop.

Maize growing areas in Ethiopia are broadly classified into four ecological zones based on altitude and annual rainfall. These are the high altitude moist zone, which receive 1200 to 2000mm annual rainfall with an altitude of 1700 to 2400 meters above sea level (m.a.s.l), the mid-altitude moist zone (1200-2000 mm annual rainfall with an altitude of 1000 to 1700 m.a.s.l), the low–altitude moist zone with less than 1000 m.a.s.l and 1200 -1500 mm annual rainfall), and the moisture stress zone with 500 to 1800 m.a.s.l and less than 800 mm annual rainfall. Currently, maize is a major crop in Ethiopia in terms of production, consumption and income generation for human beings. In Ethiopia, during the 2015 cropping season, 2,110,209.61 hectares of land was covered with maize with an estimated production of about 72,349,551.02 [3].

Maize breeding in Ethiopia has been ongoing since the 1950's and has passed through three distinctive stages of research and development [4]. These are from 1952 to 1980, the main activities were the introduction and evaluation of maize materials from different part of the world for adaptation to local condition, from 1980 to 1990, the work was focused on evaluation of inbred lines and development of hybrid and open-pollinated varieties. From 1990 to the present, the main activities were (a) extensive inbreeding and hybridization, (b) development of early maturing or drought tolerant cultivars, and (c) collection and improving of maize with adaptation to highland agro ecologies. As a result, various improved hybrids and open-pollinated varieties were released for large-scale production, especially for mid-altitude zones. The high land maize breeding program was also started in 1998 in collaboration with the international maize and wheat improvement center [4].

The main goal of all maize breeding programs is to obtain new open pollinated varieties (OPVs), inbred lines and from them hybrids and synthetics that will outperform the existing cultivars with respect to a number of traits. In working toward this goal, attention needs to be paid to grain yield as the most important agronomic trait [4].

Grain yield is a complex quantitative trait that depends on a number of factors. It's highly influenced by environmental conditions; has complex mode of inheritance and low heritability. Because of this, during selection for grain yield, attention is given first to determine mean values, components of variance and the heritability of yield related traits in order to establish the best selection criteria [5].

Besides, knowing the correlations between the traits is also of great importance for success in selection to be conducted in breeding programs, and analysis of correlation coefficient is the most widely used one among numerous methods [6].

Success in any crop improvement or breeding program depends upon the selection of suitable parents, a thorough knowledge of genetic variability, heritability and type of gene action. In addition, traits upon which selection of parents is based should be known. Relatively higher estimates of genotypic coefficient of variation for grain weight, plant height, ear placement, kernel rows per ear and number of grains per row along with high heritability suggest that the selection can be effective for these traits [7].

A number of studies in maize have been conducted to elucidate the nature of association between yield and its components which identified traits like ear length, ear diameter, kernels per row, ears per plant, 100-seed weight and rows per ear as potential selection criteria in breeding programs aimed at high yield [7].

According to [8] who reported in his study on phenotypic diversity for morphological and agronomic traits in traditional Ethiopian highland maize accessions, highland maize varieties may be grouped into a number of completely or partially isolated populations, which may be adapted to different highland conditions. [9] also reported in his study on genetic diversity of maize inbred lines by AFLP Markers that seven pairs of AFLP primers identified 499 scorable fragments out which 81.7% were polymorphic and the diversity varying from 0.35 to 0.71. The above are among the limited studies made on maize genetic diversity in Ethiopia. The currently proposed study involves maize germplasm which were not used by other researchers for similar studies in this locality and would contribute positively to the study area. Thus, the general objective of this study was to find out the nature and magnitude of genetic variability for different traits in maize genotypes with specific objectives to:-

- Estimate the nature and magnitude of genetic variability for the yield and yield related traits in maize genotypes.
- Determine the heritability and genetic advance of some agronomic traits.

II. MATERIALS AND METHODS

2.1. Description of the Study Area

The experiment of this study was conducted in Humid Tropical area. Abaya district is situated Kolla (70%) and Woina Dega (30%) and an altitude of 1630 meters above sea level. The average annual rainfall is 977.5 mm. The average monthly maximum and minimum temperature is 10.0^0c and 24.0^0c, respectively. The area is dominated by clay soil while loam soil, black soil and verti-soil are also present (Guangua Rural Agricultural office, 2015).

2.2. Treatments and Experimental Design

Twelve maize genotypes were used for the study. The sources of the genotypes were Melkassa Agricultural Research Centre, Guangua and Dilla Rural and Agricultural Offices. The description of the genotypes was depicted in Table 1.

The experiment was carried out in a randomized complete block design with four replications. Each plot consisted of 4 rows of 5.1m in length with row to row spacing of 75cm and within row spacing of 25 cm. All agronomical practices were carried out as recommended for the area.

2.3. Data Collection

Days to 50% anthesis: the number of days from emergence to when 50% of the plants started shedding pollen.

Days to 50% silking: the number of days from emergence to when 50% of the plants in the plot produced 3cm long silk.

Table 1: Description of Genotypes

No.	Name	Description
1. 1	Melkassa-4	Composite
2	Jabi	Hybrid
3	Limu	Hybrid
4	Melkassa hybrid -130	Hybrid
5	Shone	Hybrid
6	Shala	Hybrid
7	Bako hybrid-543	Hybrid
8	Melkassa 6 Quality protein	Composite
9	Melkassa hybrid -140	Hybrid
10	Bako hybrid-140	Hybrid
11	Bako hybrid-660	Hybrid
12	Bako hybrid-661	Hybrid

Source: Melkassa Research Centre, Guangua and Dilla Agricultural and Rural Offices

Days to 75% maturity: the number of days from emergence to when 75% of the plants in the plot reached physiological maturity.

Plant height (cm): heights of five randomly taken plants from each plot measured from the ground level to the base of tassel and the average was recorded.

Ear height (cm): ear heights of five randomly taken plants from each plot were measured from

Number of ears per plant: number of ears per plant from five randomly taken plants of each plot was counted and the average was recorded.

Ear length (cm): length of five randomly taken ears from each plot was measured using centimeter and the average was recorded

Ear diameter (cm): diameter of five randomly taken ears from each plot was measured using caliper and the average was recorded.

Number of kernels per row: the number kernels/row from five randomly taken ears/plot was counted and the mean was recorded.

Number of rows per ear: the number of rows/ear from five randomly taken ears from each plot was counted and the mean was recorded.

1000 kernel weight: thousands of kernels from each plot were counted by automatic seed counter and were weighed using a sensitive balance after adjusting the moisture content to 12.5%.

Adjusted yield (kg/plot): the yield of grain of each plot were weighed and adjusted to 12.5% moisture. Adjusted yield per plot= (FW×0.81) × (100-MMR)/ (100-12.5)

Grain yield (kg/ha): this was calculated by converting plot yield into hectare basis.

GY= (Yield per plot (g) / Plot size) X 10000 m^2

Statistical Analysis

2.4. Analysis of variance

Analysis of variance (ANOVA) was carried out for the quantitative traits as per the procedure outlined by [10]; SAS software [11] was used to analysis.

Estimation of genetic parameters

The amount of genotypic and phenotypic variability that exist in a species is essential in developing better varieties and in initiating a breeding program. Genotypic and phenotypic coefficients of variation are used to measure the variability that exists in a given population [12].

Phenotypic and genotypic variance components and of phenotypic and genotypic coefficients of variation were calculated by the methods suggested by [12].

Genotypic variance (σ^2_g) = $\frac{Msg - Mse}{r}$

Phenotypic Variance (σ^2 p) = σ^2 g +σ^2 e

Environmental Variance (σ^2 e) = Mean Square error

Where Msg= mean square due to genotype

Mse= environmental variance

r= the number of replication
Phenotypic coefficient of variation (PCV)

$$PCV= \frac{\sqrt{\sigma_p^2}}{x} x\ 100$$

Genotypic coefficient of variation (GCV)

$$GCV = \frac{\sqrt{\sigma 2g}}{\bar{x}} \times 100$$

Where X = trait means

PCV and GCV values were categorized as low, moderate and high values as indicated by [13] as follows.

0-10 % = Low
10-20% = Moderate
>20 = High

Heritability in Broad sense for all traits was computed using the formula given by [14]

$$Heritability\ (H) = \frac{\sigma_g^2}{\sigma_p^2} \times 100$$

Where (H) = heritability in broad sense
σ_p^2= phenotypic variance
σ_g^2= genotypic variance
The heritability percentage was categorized as low, moderate and high as followed by [15], as follows.

0-30% = Low
30-60% = Moderate
>60% = High

Genetic advances under selection (GA) expected genetic advances for each trait at 5% selection intensity was computed by the formula described by [16].
Genetic advances (GA) = K. σ^2 p. H

Where K= constant (selection differential where K= 2.056 at 5% selection intensity)
σ_p = phenotypic standard deviation
H= heritability in broad sense
Genetic advances as percent of means was calculated to compare the extent of predicated advances of different traits under selection using the formula.

$$GAM= (GA / \bar{X}) \times 100$$

Where GAM= genetic advances as percent of mean
GA= Genetic advances under selection
$\bar{X}$ = mean of population in which selection was employed.

The GA as per cent of mean was categorized as low, moderate and high as described by [16] as follows.

0-10 % = Low
10-20% = Moderate
20 and above = High

III. RESULTS AND DISCUSSION

3.1. Analysis of variance

The mean squares due to genotype were highly significantly different ($p < 0.01$) for all the traits studied except for the number of ear per plant, ear length, ear diameter and kernels per row, which indicates the existence of sufficient genetic variability (Table 2).

In line with the current study, [17] reported significant difference in thousand seed weight and days to silking in maize varieties; and in addition, he reported that the highest genetic gain was obtained for plant height and the ***lowest genetic gain for number of leaves per plant. [18]; [19]; [20] and [21] also reported similar results.***

Table 2: Mean squares from analysis of variance of the 12 maize genotypes evaluated

SV	DF	DA	DS	DM	PH	EH	EPP	EL	ED	KPR	RPE	TKW	GY
Rep	3	1.69	2.83	0.61	34.36	76.15	0.06	3.98	0.02	16.02	0.14	108.53	0.04
Gen	11	14.29**	14.11**	891.38**	7907.11**	1992.82**	0.10ns	5.31ns	0.07ns	10.58ns	3.01**	11620.77**	9.28**
Error	33	5.29	5.45	1.96	13.45	28.92	0.06	3.77	0.07	7.34	0.46	14.65	0.06
G.Mean		78.02	78.92	168.58	176.63	88.66	1.37	17.96	4.33	34.10	13.49	404.19	8.90
CV		2.95	2.96	0.83	2.08	6.07	17.18	10.80	5.91	7.94	5.04	0.95	2.69
SE		1.15	1.17	0.70	1.83	2.69	0.12	0.97	0.13	1.35	0.34	1.91	0.12
LSD		3.31	3.36	2.01	5.28	7.74	0.34	2.79	0.37	3.90	0.98	5.51	0.34

SV=source of variation, Rep=replication, Gen=genotype, G.mean=grand mean, R^2 = R-square, CV= coefficient of variation, SE = Standard error, LSD = Least significant ** at p [< 0.01], DA=Days to 50% anthesis, DS=Days to 50% silking, DM=Days to 75% maturity, PHT= plant height, EHT= ear height, LL= leaf length, LW=leaf width, AGBM= above ground biomass, EPP = ears per plant, EL =Ear length , ED = Ear diameter , KPR = kernels per row , RPE = row per ear , TKW = 1000Kernel weight, KT= kernel type, GY=grain yield, and HI = harvest index.

3.2. Range and mean values

The range means and standard errors of the 12 traits studied were shown in Table 3. Wide ranges were recorded for thousand kernel weight (311.5-518), plant height (63-230), ear height (52.60-127) and days to maturity (159-219). Similarly, number of kernel per row (23-37), days to silking (70-83), days to anthesis (70-82) and ear length (13.2-22.40) had wide ranges. Grain yield per hectare ranged from 6.78 tons for Melkasa-4 to 11.75 tons for Limu. Maximum grain yield per hectare was obtained from Limu (11.75 t), and Jabi (11.30 t) while low grain yield were obtained from Melkassa-4, BH-140, and BH-543 6.78 t, 7.20 t and 7.48 t per hectare in that order (Table 4).

Days to anthesis and days to silking ranged from 74.75 and 75.75 for Melkassa 4 to 81 and 82.25 for jabi in that order. Days to maturity was ranged from 159.5 for Melkassa 6 Q to 215.25 for BH-660. Plant height and ear height were ranged from 65.75 cm 226.50 cm for BH-545 and shone in that order. The range for number of ears per plant was 1.10 for shala and 1.60 for Jabi. Ear length ranged from 15.88 for Melkassa 4 to 19.62 for limu whereas ear diameter was from 4.15 for BH-661 to for shala. Number of kernels per row ranged from 30.70 to 36.40 for BH-661 and limu in that order while number of row per ear was from 12.25 for BH-543 and Melkassa hybrid 130 to 15 for jabi. Thousand kernel weights ranged from 314.38 gram for Melkassa hybrid 130 to 511.25 for jabi (Table 3).

[22] reported that the components of variance revealed a wide range of variability for traits such as number of rows per ear, kernels per row, kernels per ear, ear length, ear diameter, 100-kernels weight and plant height.

[8] also reported that grain yield, plant height, ear height and days to maturity showed wide range of variation, while number of leaves, leaf width and ear diameter showed a narrower range of phenotypic variation of maize in Ethiopia. In general, range and mean values in this study suggested the existence of sufficient variability among the tested genotypes for the majority of the traits studied and their considerable potential in the improvement of maize crop.

Table 3: Mean performance 12 quantitative traits of 12 maize genotypes

NO.	Genotype	DA	DS	DM	PH	EH	EPP	EL	ED	KPR	RPE	TKW	GY
1	Jabi	81.00a	82.25a	164.50dce	217.25b	111.25b	1.60	19.47	4.18	32.90	15.00a	511.25a	11.30b
2	Limu	79.75ba	80.50ba	165.25dc	215.75b	121a	1.43	19.62	4.20	36.40	14.50ba	476.31b	11.75a
3	BH-660	79.50bac	80.00bac	215.25a	160.25edf	76.80ed	1.45	18.26	4.34	33.20	14.25bac	419.25d	8.15e
4	Shala	79.25bac	80.00bac	164.50dce	184.25c	92.00c	1.10d	17.58	4.63	35.40	13.00edf	406.95e	9.45c
5	Melkassa 6 Q	79.00bac	80.25bac	159.50g	165.50d	74.50ef	1.58	16.41	4.33	34.20	14.25bac	398f	8.60d
6	BH-661	78.50bdac	79.25bdac	170.00b	225.75a	111.75b	1.57	18.94	4.15	30.70	13.75bdc	363.88h	9.48c
7	Shone	78.25bdac	79.00ebdac	166.50c	226.50a	123.00a	1.38	18.06	4.43	34.40	13.75bdc	450.63c	9.60c
8	BH-140	78.00ebdac	78.75ebdc	165.00dce	179.75c	84.00d	1.25	18.50	4.44	35.15	13.00edf	362.64h	7.20f
9	MH-140	76.50ebdc	77.75ebdc	163.00fe	155.25f	65.25g	1.39	17.47	4.43	34.60	12.75ef	379.61g	8.25e
10	MH-130	76.25edc	77.00edc	165.00dce	159.50ef	72.00efg	1.28	17.00	4.35	32.20	12.25f	314.38i	8.80d
11	BH-543	75.50ed	76.50ed	161.00gf	65.75g	66.85fg	1.28	18.36	4.40	35.90	12.25f	385g	7.48f
12	Melkassa 4	74.75e	75.75e	163.50de	164.00ed	65.50g	1.20	15.88	4.47	34.15	13.88bdc	382.43g	6.78g
LSD		3.31	3.36	2.01	5.28	7.74	0.34	2.79	0.37	3.90	0.98	5.51	0.34

DA=Days to 50% anthesis, DS=Days to 50% silking, DM=Days to 75% maturity, PH= plant height, EH= ear height, EPP = No. of ears per plant, EL =Ear length, ED = Ear diameter , KPR = No. of kernels per row , RPE = No. of row per ear , TKW = 1000-Kernel weight, and GY/ha = Grain yield per hectare.

3.3. Phenotypic and genotypic variations

The high phenotypic and genotypic coefficient of variations were observed from number of ear per plant (45.44 and 41.77), and ear diameter (24.60 and 23.83) in that order. On the other hand, relatively moderate values were recorded for grain yield per hectare (16.93 and 16.70), ear length (15.06 and 10.49), number of rows per ear (14.29 and 13.38) for phenotypic and genotypic coefficient of variation in that order. Moderate phenotypic coefficient of variation was observed from number of kernels per row (10.49). The remaining traits depicted low phenotypic and genotypic coefficient of variations (Table 4).

In the current study, number of ear per plant, and ear diameter had high phenotypic and genotypic coefficient of variation and hence these traits provide greater chance for effective selection whereas grain yield per hectare, ear length and number of rows per ear had moderate genotypic and phenotypic coefficients of variation, and hence these traits provide average chance for selection. In contrary, thousand kernel weights (2.62 and 2.44), days to maturity (3.92 and 3.83), plant height (4.17 and 3.62), days to silking (6.18 and 5.43), days to anthesis (6.21 and 5.47) and ear height (7.47 and 4.36) had the least phenotypic and genotypic coefficients of variation in that order, and hence these traits provide less chance for selection (Table 4).

In this study, it was found that phenotypic coefficients of variations were higher than genotypic coefficients of variations for all traits. This might be due to the fact that there is high environmental effect on the studied genotypes. This observation was in line with that of [17] who reported high phenotypic coefficient of variation than genotypic variation in his study on maize. According to [23], traits having high GCV indicate high potential for effective selection.

3.4. Heritability estimates

Broad sense heritability (h^2), an estimate of the total contribution of the genotypic variance to the total phenotypic variance ranged from 34.06 % for ear height to 97.36% for grain yield per hectare (Table 6). All traits had high heritability estimates as followed for grain yield per hectare (97.36%), days to maturity (95.51%), ear diameter (93.83%), number of row per ear (87.63%), thousand kernel weight (86.92%), number of ear per plant (84.52%), days to anthesis (77.46%), days to silking (77.12%), and plant height (75.21%). Relatively moderate estimates of heritability were recorded from ear length (48.48%), number of kernels per row (47.68%), and ear height (34.06%) indicating that all the studied traits may respond positively to phenotypic selection (Table 4).

These observations are in agreement with the findings of [24] who reported high heritability estimates for number of kernels per row (86%), plant height (85%),ear height (83%), physiological maturity (82%), number of rows per ear (77%), ear length (73%), emphasizing that the additive genetic variation was the major component of genetic variation in the inheritance of these traits and the effectiveness of selection in the early segregating generations of the genotypes for improving these traits. [25] and [26] also observed in their study on maize high heritability estimates for the traits such as grain yield per plant (96.80%), ear height (92.77%), days to 50 per cent tasseling (89.27%), days to 50 per cent silking (88.57%), plant height (93.53%), cob length (85.97%), number of kernels per row (72.80%) and 1000-kernels weight (84.43%).

3.5. Estimates of expected genetic advance

The genetic advances as percent of the mean (GAM) at 5% selection intensity is presented in Table 4. It ranged from 4.68% for thousand kernel weight to 78.95 % for number of ear per plant. High genetic advance expressed as percentage of mean was obtained from number of ear per plant (78.75%), ear diameter (47.47%), grain yield per hectare (33.89%), and number of row per ear (25.75%), depicting that these traits were under the control of additive genes (Table 4).

The current observations were in confirmation with the findings of [25] who reported similar results in their study on maize genotypes. On the other hand moderate estimates of genetic advance expressed as percentage of mean were observed for ear length (15.01%) and number of kernels per row (10.77%).

Low estimates of genetic advances expressed as percentage of mean were observed for thousand kernel weights (4.68%), ear height (5.23%), plant height (6.45%), days to maturity (7.69%), days to silking (9.80%) and days to anthesis (9.89%), indicating the presence of low genetic variability for these traits which are also reflected by their respective low genotypic and phenotypic variations. This in turn showed the importance of genetic variability for the improvement of the traits through selection (Table 4).

Table 4: Estimates of ranges, Standard error (SE), Phenotypic (σ^2p) and Genotypic (σ^2g) variance, Phenotypic coefficient of variability (PCV) and Genotypic Coefficient of variability (GCV), Broad sense heritability (H), Expected genetic advances (GA) and Genetic advance as percent of mean (GAM).

Traits	Range	Mean	±SE	(σ^2 p)	(σ^2g)	(σ^2e)	PCV	GCV	H%	GA	GA%
DA	70.00-82.00	78.02	1.15	23.47	18.18	5.29	6.21	5.47	77.46	7.72	9.89
DS	70.00-83.00	78.92	1.17	23.82	18.37	3.45	6.18	5.43	77.12	7.74	9.80
DM	159-219	168.58	0.70	43.62	41.66	1.96	3.92	3.83	95.51	12.97	7.69
PH	63-230	176.63	1.83	54.25	40.80	13.45	4.17	3.62	75.21	11.39	6.45
EH	52.6-127	88.66	2.69	43.86	14.94	28.92	7.47	4.36	34.06	4.64	5.23
EPP	0.70-2.20	1.37	0.12	0.39	0.33	0.06	45.44	41.77	84.52	1.08	78.95
EL	13.20-22.40	17.96	0.97	7.32	3.55	3.77	15.06	10.49	48.48	2.70	15.01
ED	3.70-4.80	4.36	0.13	1.14	1.07	0.07	24.60	23.83	93.83	2.06	47.47
KPR	23.00-37.00	34.10	1.35	14.03	6.69	3.74	10.98	7.59	47.68	3.67	10.77
RPE	12.00-15.00	13.49	0.34	3.72	3.26	0.46	14.29	13.38	87.63	3.47	25.75

TKW	311.5-518	404.19	1.91	112.04	97.39	14.65	2.62	2.44	86.92	18.92	4.68
GY/ha	6.5-12.00	8.90	0.12	2.27	2.21	0.06	16.93	16.70	97.36	3.02	33.89

DA=Days to 50% anthesis, DS=Days to 50% silking, DM=Days to 75% maturity , PH= plant height , EH= ear height, EPP=number of ear per plant, EL =Ear length , ED = Ear diameter , KPR = No. of kernels per row , RPE = No. of row per ear , TKW = 1000-Kernel weight .

IV. SUMMARY AND CONCLUSION

4.1. Summary

The progress of crop improvement program depends on the choice of the breeding material, the extent of variability and the knowledge of quantitative traits with yield and yield related traits. In view of this, the current study was initiated to find out the nature and magnitude of genetic variability for different traits in maize genotypes.

Analysis of variance showed the presence of highly significant differences among the tested genotypes for most of the traits considered which indicates the existence of sufficient genetic variability and there were fewer coefficients of variations in all of the traits indicating good precision of the experiment.

The ranges of mean values for most of the traits were large showing the existence of variation among the tested genotypes. Phenotypic coefficients of variation (PCV) were found to be higher than genotypic coefficients of variation (PCV) for all the traits. The two values differed slightly indicating less influence of the environmental factors. The highest phenotypic and genotypic coefficients of variations were observed for number of ear per plant, ear diameter, grain yield per hectare, number of rows per ear, and ear length. 100-kernel weights, days to maturity, plant height, days to anthesis, days to silking, and ear height had the least phenotypic and genotypic coefficients of variations.

Higher heritability values were obtained for grain yield per hectare, days to maturity, ear diameter, number of rows per ear, 1000-kernel weight, number of ear per plant, days to anthesis, days to silking and plant height. Moderate estimates of heritability were observed for leaf length, number of kernels per row, and ear height. Genetic advance expressed as percentage of mean (GAM) was high for number of ear per plant, ear diameter, grain yield, and number of row per ear. Low estimates of genetic advances expressed as percentage of mean were observed for 1000-kernel weights, number of days to anthesis, silking, maturity, plant and ear heights.

4.2. Conclusions

The result indicated the existence of genetic variability in the maize genotypes studied and this can be exploited in the future breeding program. It can also be seen that genotypes Limu, Jabi, shone, BH-661, and shala from among the hybrid varieties and Melkassa 6 Quality protein from local varieties gave high grain yield under Guji condition indicating their potential to promote for production around Guji areas.

In general, ear diameter, number of row per ear and ear per plant, thousand kernel weight, Plant height, maturity traits, should be used as selection criteria for yield improvement in maize. The genetic variability among genotypes observed should be utilized for future maize improvement program.

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