Variability and Trait Association in Maize (*Zea mays*) Varieties for Growth and Yield Traits in Dadin-Kowa, Gombe State

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Abstract
The experiment was conducted at Teaching and Research Farm of Federal College of Horticulture Dadin-Kowa Gombe State, Nigeria during the main cropping season of 2023 (July to November, 2023). The experiment aimed to determine the magnitude and extent of variability and the association between traits and their contribution to yield in maize genotypes. Ten maize genotypes were considered in the trial. The field experiment was laid out in a Randomized Complete Block Design (RCBD) and replicated three times, totaling thirty plots. Data were collected on the growth and yield parameters. Statistical analysis of variance (ANOVA) was conducted on the collected data, and significant differences among the treatment means were separated using Duncan's Multiple Range Test (DMRT) test at 5% level of significance. The results showed that genotypic mean squares were significant in number of ears per plant, ear diameter, 1,000 of grain weight, grain yield in tons per hectare, stem diameter, leaf area, and number of grain row per ear, indicating the presence of variability among the studied genotypes. Oba 98 demonstrated superiority over other genotypes in most traits studied followed by SAMMAZ 18. The genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were compared, with the PCV being higher than the GCV, indicating the influence of environmental factors on all investigated traits. Number of ears per plant (45%), grain yield per plot (43%) and grain yield in tons per hectare (43%) showed high broad-sense heritability, while number of leaves (6%) and leaf area (6%) had lower heritability. Path analysis suggested direct selection for traits like ear diameter to improve grain yield.

Key words: *Genotype, Growth, Maize, Variability, Yield.*

INTRODUCTION

Maize (*Zea mays*) is a versatile crop that serves various purposes, such as providing food for humans, feed for poultry, livestock fodder, and edible oil, among others. It is widely cultivated due to its adaptability to diverse environments and holds a significant position as a staple food crop in Nigeria and worldwide. Maize is also gaining attention in industrial development (Mamud, 2021). Open-pollinated varieties (OPVs) of maize are primarily farmer-bred cultivars that yield grains suitable for seed preservation for the subsequent season. OPVs play a crucial role in developing cultivars capable of withstanding extreme weather conditions, resisting pathogens, and insect pests. These attributes contribute to stabilizing yields by reducing excessive variations (Magar *et al.*, 2021). This highlights the importance of conserving and effectively utilizing the genetically diverse open-pollinated genotypes through various breeding programs, ultimately promoting the development of new varieties. However, it is worth noting that OPVs, which can perform as well as hybrids, are not thoroughly evaluated or widely disseminated in the research community, which could reveal the most suitable OPVs. The effectiveness of a crop depends not only on the genetic variability within the population but also on its heritability (Magar *et al.*, 2021). Understanding the genetic variability in a crop species for traits targeted for improvement is crucial for the success of any plant breeding program (Isha *et al.*, 2015). Parameters such as genotypic and phenotypic coefficients of variation (GCV and PCV) help assess the variability in specific characteristics. The efficiency of exploiting genotypic variability through selection depends on heritability and the genetic advance (GA) of individual traits (Begum *et al.*, 2016). Accurate heritability estimates are essential for improving plants with quantitative traits in an efficient breeding program (Ogunniyan and Olakojo, 2015). Yield in maize is a complex trait influenced by various contributing characteristics. Direct selection for yield alone may not be the most efficient method for improvement. Instead, indirect selection for other yield-related traits with high heritability estimates is often more effective (Oluwagbenga and Stephen, 2020). Understanding the presence of genetic variability in germplasm for yield and its related components, as well as the genetic differences among cultivars, is crucial in plant breeding programs. Genetic correlation analysis is a valuable technique that explores associations among quantitative traits (Maruthi and Jhansi Rani, 2015). The study of characters' associations, along with heritability and genetic variability, has been applied in major crops like rice, wheat, barley, and maize, to enhance the genetic diversity of local germplasm (Maruthi and Jhansi Rani, 2015). Additionally, efficient selection in any breeding program relies on the knowledge of trait associations. Phenotypic correlation indicates the degree of association between two traits, while genotypic correlation provides insight into the inherent association between genes controlling two traits. Path analysis is essential for understanding the cause and effect of traits, aiding in the formulation of selection indices for improving yield (Oluwagbenga and Stephen, 2020). One of the most crucial agronomic traits in maize is grain yield, which depends on various factors like days to anthesis, days to silking, tassel branches, plant height, ear height, leaf dimensions, ear weight, kernel properties, and more. Genotypes possessing desirable traits significantly contribute to grain yield (Magar *et al.*, 2021). Grain yield is highly influenced by kernel set, which is sensitive to environmental conditions during anthesis and silking stages (Yadav *et al.*, 2015). Therefore this research is aimed to determine the magnitude and extent of variability and the association between traits and their contribution to yield in maize genotypes.

2.0 MATERIALS AND METHODS

2.1 *Description of the Studied Area*

The experiment was conducted at the Federal College of Horticulture Dadin-Kowa Research and Demonstration Farm located along the Gombe-Biu Road. The area lies between latitudes 10° and

15° N and longitudes 11° and 15° E in the Northern Guinea Savannah Ecological Zone of Nigeria. The climate in this region consists of two distinct seasons: rainy season (May to October) and dry season (November to April). The mean annual rainfall is about 350mm per annum, with temperatures ranging from 30°C to 32°C. The inhabitants of Dadin – Kowa are mainly engaged in agrarian pursuits of cultivating arable crops and rearing livestock on a free-range and semi intensive basis. The soils are mainly sandy. Crops like groundnut, sorghum, millet, and cowpea are prominent produce in the area. Others include pepper, vegetables, onion, water melon, carrots and okra. The domestic animals reared are goat, cow, chicken and sheep. Hence the seeds used for this research, was sourced from the Institute for Agricultural Research (IAR) Zaria Kaduna State and local market in Dadin – kowa.

2.2 *Field Treatment*

The study consists of 10 maize varieties as treatments. Which were obtained from Agricultural Research Zaria, Kaduna State. These was laid out in a Randomized Complete Block Design (RCBD) with plot dimensions of 3x2 m² and replicated three times. Each replicate consist of ten (10) plots, and each plot was 2x3m with a total area of 6m². Each plot was separated by a distance of 0.5m, and each replicate was equally separated by 1m for easy passage and cultural practices. The size of each replicate was 24.5m x 3m, and the total plot area was 24.5m x 11m. Distance between row-to-row and plant to plant was 75cm and 25cm respectively.

2.3 Cultural Practices

Land Preparation: The land was cleared by the use of cutlasses, while shrubs, grasses, and trashes were packed and burnt. The land was ploughed and harrowed or tilled by the use of a hoe. To reduce experimental error as a result of soil heterogeneity, the length and width of the plot were marked out with measuring tape and peg. A garden line was used for making straight lines with uniform plots of equal sizes.

Planting: Two seeds were planted per hole, and then seedlings were thinned to one plant at the 4-5 leaf stage to maintain one plant per hole.

Weeding: The weeding was done at two (2) weeks intervals to avoid competition with weeds and to prevent pest and disease infestation. Hands hoeing was used during the weeding.

Fertilizer Application: The plots were fertilized with NPK and Urea at a rate of 100 kgha $^{-1}$ for NPK and 100 kgha^{-1} for Urea. The NPK was applied one week after planting. The Urea was applied in two equal splits. The first half was applied six weeks after planting, and the second half was applied after two weeks or when it started producing tassel (Male flowers).

Data measurement

Data were recorded for the following parameters i.e. Days to 50 percent anthesis**,** Days to 50 percent silking**,** Plant height (cm)**,** Ear height (cm)**,** Number of leaves per plant**,** Leaf length (cm), Leaf width (cm), Number of tassel branches, Ear length (cm), Stem diameter (mm), Ear diameter (mm), Number of grain rows per ear**,** Number of grain per row**,** Number of ears per plant, One Thousand grain weight (Kg), Field weight per plot**,** Field weight in tons per hectare**,** Grain yield per plot**,** Grain yield per hectare (kg), Grain yield $= \frac{\text{Grain yield per hectare (kg)}}{\text{Net plot size (m2)}} X\ 10{,}000\text{m}^2$

Above-ground biomass yield per plot (kg), Above-ground biomass yield in tons per hectare (kg)**,**

Harvest index (%), Harvest index (%) $= \frac{\text{Economic (grain)}\mathit{yield}\ (\frac{kg}{ha})}{\text{Above ground biomass}\ \left(\frac{\text{kg}}{\text{ha}}\right)} \times 100$

All the data were recorded according to their standard methods.

2.4 Data Collection

Data were collected from ten plants in the two roles within the plot for recording and observations of all quantitative traits. The mean of ten plants for each plot in each treatment was worked out for each trait and recorded, then used for statistical analysis.

2.4 Analysis of Variance

Analysis of variance was carried out for all the traits using the procedure outlined by Gomez and Gomez (1984), by using IBMSPSS version 23. The significance of the difference among the treatment means was estimated by the Duncan's Multiple Range Test (DMRT) test at 5% level of significance.

3.0 RESULTS

3.1 Analysis of Variance

The mean squares due to grain yield and yield-related traits are presented in Table 1. The results showed that genotypic mean squares were significant ($p \leq 0.05$) in number of ears per plant, ear diameter, 1000-grain weight, and grain yield tons per hectare, which suggested that, there is variability among the genotypes under study. However, there were no significant difference on number of leaves, plant height, ear height, leaf length, leaf width, leaf area, number of tassel branches, stem diameter, days to 50% anthesis, days to 50% silking, ear length, number of grain rows per ear, number of grains per row, field weight in tons per hectare, grain yield per plot, grain yield in tons per hectare, above-ground biomass yield per plant, above-ground biomass yield in tons per hectare, and harvest index this may indicates closed variability among the traits examined. The mean performance for grain yield and other related traits of maize genotypes are presented in Table 2. The results showed that there were significant differences between maize genotypes in number of ears per plant, ear diameter, 1000-grain weight, and grain yield tons per hectare. Additionally, there were no significant differences observed in plant height, leaf width, stem diameter, days to 50% anthesis, ear length, and number of grain rows per ear, and harvest index. Among all the genotypes.

3.2 Estimates of Variance Components

The GCV and PCV values for various traits are presented in Table 3. The genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were compared in this study. Overall, the PCV was higher than the GCV. Among the maize genotypes examined, low, moderate, and higher variability were observed for most of the traits on PCV. Plant height (22.20), above-ground biomass yield tons per hectare (23.60), and Harvest index (24.26) were estimated to have high PCV, while moderate PCV was observed for ear height (12.00), leaf area (13.57), stem diameter (10.92), number of tassel branches (15.94), grains yield in tons per hectare (13.10), and

field weight in tons per hectare (12.71). On the other hand, low PCV and low GCV were estimated for traits like ear diameter (6.38, 4.88), 1000-grain weight (5.83, 2.91), days to 50% anthesis (4.14, 1.45), days to 50% silking (2.97, 0.75), number of grain rows per ear (6.14, 2.06), number of grains per row (9.78, 3.98), and ear diameter (6.38, 4.88), ear length (7.82, 1.35).
Table 2. Shows the mean performance for grain yield and other related traits of maize genotypes. There were significant differences between maize genotypes in number of ears per plant, ear diameter, 1000-grain weight, and grain yield tons per hectare. However no significant differences was observed in plant height, leaf width, stem diameter, days to 50% anthesis, ear length, and number of grain rows per ear, and harvest index.

3.3 Heritability and Genetic Advance

According to Magar *et al.* (2021), Heritability was classified as low (less than 30%), moderate (30–60%), and high (more than 60%) estimates of heritability for the various traits studied, The highest heritability (45%) was found in the number of ears per plant, followed by grain yield tons per hectare (43%), and ear diameter (42%). Similarly, heritability values for the number of leaves (5%) and ear length (3%) were lower values of heritability. The rest of the traits studied were moderately heritable. Table 3. Showed the heritability values for all traits, similarly, genetic advance for the traits in the study ranged from 0.1% for the number of ears per plant to 12.00% for grain yield in tons per hectare. The observed genetic advance values were classified as low (less than 10%), moderate (10–20%), and high (greater than 20%). Table 3. Shows the genetic advance estimates for all traits. Grain yield tons per hectare (12%), and the number of tassels per branch (10%) had moderate estimates of genetic advance percent while others had lower estimates of genetic advance percent. Broad-sense heritability estimates varied among traits, being lowest for the number of grains per rows per ear and highest for grain yield per plant.

3.4 Path analysis of grain yield and other traits at genotypic level

Table 4. Presented the path coefficient analysis at genotypic level revealed that a direct positive effect on harvest index was exhibited by above ground biomass, number of tassel branches, 50% days to anthesis, and 1,000 grains weight.

4.0 DISCUSSION

4.1 Analysis of Variance

The result from this experiment revealed some level of significant ($p \leq 0.05$) variation among the varieties in some traits and no significant difference were also observed in some traits investigated in this study. Significant variability was observed in the following traits; number of ears per plant, ear diameter, 1000-grain weight, and grain yield tons per hectare, and indicated no significant difference among other traits; number of leaves, plant height, ear height, leaf length, leaf width, leaf area, number of tassel branches, stem diameter, days to 50% anthesis, days to 50% silking, ear length, number of grain rows per ear, number of grains per row, field weight in tons per hectare, grain yield per plot, grain yield in tons per hectare, above-ground biomass yield per plant, above-ground biomass yield in tons per hectare, and harvest index. Significant variability were observed among the genotypes, as Showed in Table 1. This suggests that there is a lot of genetic variation among the genotypes for improvement of these traits. The findings of the current study are consistent with the findings reported by Oyekola and Fayeun, (2019), who observed the significant difference among the traits studied; number of ears per plant, ear diameter, 1000-grain weight, and grain yield tons per hectare. (Magar *et al.,* 2021) who also equally observed considerable genotypic variability among various maize genotypes. Bhusal *et al.* (2017) reported pronounced variation among some maize plant for different morphological traits among some maize population. Different lines have also been evaluated for morphological and agronomic traits, showing significant amount of variation among the genotypes. On the other hand those traits, which were not significantly difference, may be as a result of influence of environmental factors. In the mean performance, it was revealed that, there were significant differences between maize genotypes in traits such as number of ears per plant, ear diameter, 1000-grain weight, and grain yield tons per hectare (Table 2). This suggests that there is a lot of genetic variation in the traits among the genotypes for improvement. The findings of the current study are consistent with the findings reported by Tadesse *et al.* (2018) and Gebre *et al.* (2018). Non-significant differences were observed in plant height, leaf width, stem diameter, days to 50% anthesis, ear length, number of grain rows per ear, and Harvest index. This indicated that, phenotypically they were equal in their performance. Among all the genotypes, Sammaz 51 exhibited a higher values in number of leaves (13.73), grains yield in tons per hectare (9.97), above-ground biomass yield per plot (3.63), and above-ground biomass yield in tons per hectare (20.67). Showed great performance due to genetic makeup of the genotype. On the other hand, OBA 98 demonstrated superiority in plant height (193.80), ear height (96.93), leaf length (87.93), leaf area (555.18), number of grains per row (34.00), field weight in tons per hectare (13.97), and 1000-grain weight (0.37) compared to other genotypes under study which translate to high yield as reported by Kumsa, *et al.* (2020).

4.2 Estimates of Variance Components

Genotypic and phenotypic coefficients of variation provide valuable insights into the extent of variability present in the studied traits and help to determine the potential for genetic improvement. The GCV and PCV values for various traits in this study were presented in Table 10. The genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were compared in this study. Overall, the PCV was higher than the GCV, indicating the influence of environmental factors on all the investigated traits. The degree of PCV and GCV was classified as low (less than 10% phenotypic and genotypic coefficients of variation), moderate (10–20% phenotypic and genotypic coefficients of variation), and high (more than 20% phenotypic and genotypic coefficients of variation). Among the maize genotypes traits evaluated in this study, low, moderate, and higher variability were observed for most of the traits on PCV in Plant height (22.20), above-ground biomass yield tons per hectare (23.60), and Harvest index (24.26) were estimated to have high PCV as described by Magar *et al.* (2021), while moderate PCV was observed for ear height (12.00), leaf area (13.57), stem diameter (10.92), number of tassel branches (15.94), grains yield in tons per hectare (13.10), and field weight in tons per hectare (12.71). All of the traits' phenotypic variances and phenotypic coefficients of variation were slightly larger than their genotypic counterparts, showing that the environment has an impact in the expression of these traits. Similar findings were reported by Kebede, *et al.* (2020). This was also supported by the findings of Lal *et al.* (2020). On the other hand, low PCV and low GCV were respectively estimated for ear diameter (6.38, 4.88), 1000-grain weight (5.83, 2.91), days to 50% anthesis (4.14, 1.45), days to 50% silking (2.97, 0.75), number of grain rows per ear (6.14, 2.06), number of grains per row (9.78, 3.98), and ear diameter (6.38, 4.88), ear length (7.82, 1.35). A higher GCV suggests a greater contribution of genetic factors to the observed variation, indicating that these traits are influenced by the genetic makeup of the maize genotypes studied. On the other hand, a higher PCV indicates a greater influence of environmental factors, such as growing conditions, on the expression of the traits. The GCV and PCV values can be used as indicators to prioritize traits for selection in maize breeding programs. Traits with high GCV values are more likely to respond positively to selection, as they are under strong genetic control. Conversely, traits with high PCV values may require more attention to environmental management and may have limited genetic potential for improvement (Barfa *et al.*, 2017; Mihoariya *et al.*, 2023). Gopalakrishna *et al.* (2023) also reported similar findings on plant height, Harvest index, above ground biomass yield per plot, and above-ground biomass yield in tons per hectare. This present study also in agree with the findings of Sinana *et al.* (2023), who reported high PCV and GCV for plant height. These findings are similar to the outcomes of Bhusal *et al.* (2017) and Sharma *et al.* (2023).

4.3 Heritability and Genetic Advance

Heritability of a character is very important to breeders because it helps to predict the extent to which selection effort will be successful in the next generation. Heritability is used to establish the extent to which a character may be passed unto the offspring by the parent. Heritability in the broad sense separates genotypic variance from environmental variance, expresses the extent to which the phenotype is determined by the genotype, which is known as the degree of genetic determination, and very useful in the selection of superior lines from homozygous lines. This signifies that these traits were less influenced by the environmental factor, hence, the presence of additive gene effect is suspected, Hence selection for improvement of such characters may be reliable. According to Magar *et al.* (2021), Heritability could be regarded as low (less than 30%), moderate (30–60%), and high (more than 60%). Estimates of heritability for the various traits studied, the highest heritability (45%) was found in the number of ears per plant, followed by grain yield tons per hectare (43%), and ear diameter (42%). Similarly, heritability values for the number of leaves (5%) and ear length (3%) were lower. The rest of the traits studied were moderately heritable. Similarly, genetic advance for the traits in this present study ranged from 0.1% for the number of ears per plant to 12.00% for grain yield tons per hectare. Genetic advance as a percent of mean is classified as low (less than 10%), moderate (10–20%), and high (greater than 20%). Grain yield tons per hectare (12.00), and the number of tassels per branches (10.00) had moderate estimates of genetic advance as a percent of mean (Table 10) while others had lower estimates of genetic advance as a percent of mean. Broad-sense heritability estimates varied among traits, being lowest for the number of grains per rows per ear and highest for grain yield per plant. This suggests that certain traits are more influenced by additive genetic effects and are more amenable to selection, as reported by Magar *et al.* (2021).

4.4 Path analysis of grain yield and other traits at genotypic level

The path coefficient analysis at genotypic level revealed that a direct positive effect on harvest index was exhibited by above ground biomass, number of tassel branches, 50% days to anthesis, and 1,000 grains weight (Table 4). However, number of grain rows per ear, number of grains per row, ear diameter, ear length, number of ear per plant, plant height and grain yield per plot had the negative direct effect on harvest index. The significant and positive correlation between harvest index and above ground biomass is due to indirect effect of number of tassel branches on harvest index. This indicates that breeding for harvest index (HI) can be conducted through indirect selection for AGBYkgha (not direct selection through Plant height {PH}) and also thousands of grains weight (THOGW) and Number of grain per row (NGPR) were significant and positive correlation between harvest index due to indirect effect of Number of tassel branches (NTB) and Above ground biomass yield per hectare (AGBYkgha) on HI respectively. The path analysis has shown that breeding for Harvex index can be conducted through direct selection for NTB, AGBYkgha, Days to 50% anthesis (DTA) and THOGW, and by indirect selection of PH, NGRPE, ED, NEP and NGPR.

Conclusions

Among all the genotypes, OBA 98 demonstrated superiority over other genotypes in most of traits studied, followed by SAMMAZ 18. The genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were compared in this study. Overall, the PCV was higher than the GCV, indicating the influence of environmental factors on all the investigated traits. High magnitude of Broad sense heritability was estimated in the number of ears per plant (45%), followed by grain yield tons per hectare (43%), and ear diameter (43%). Similarly, low heritability were estimated in the number of leaves (6%) and ear length (3%). Moderate genetic advance as a percent of mean was observed in Grain yield per plot (11.30%) Grain yield in tons per hectare (11.56%). OBA 98 emerged as a promising genotype for maize crop improvement, followed by Sammaz 18, particularly in enhancing grain yield and other yield components in the study area. The study found that field weight (tons per hectare) and thousand-grain weight were positively correlated with grain yield at both phenotypic and genotypic levels. The analysis suggests that breeding for grain yield can be improved through direct and indirect selection of specific traits.

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Table 1: Mean Squares for Twenty-two (22) Traits of Maize Genotypes.

Traits	**Replication (df=2)**	**Mean sum of squares** **Genotypes (df = 9)**	**Error (df =18)**
No. of leaves (NL)	3.94**	0.77	0.65
Plant height (PH)	196.80	1073.40	1561.28
Ear Height (EH)	209.66	151.82	87.85
Leaf length (LL)	13.03	35.80	26.04
Leaf width (LW)	0.50	0.27	0.54
Leaf Area (LA)	4008.89*	4166.76	5049.15
Number of tassel branches (NTB)	10.58	12.05	5.39
Stem Diameter (SD)	2.67	3.47	4.14
Days to 50% anthesis (DTA)	593	5.10	3.59
Days to 50% silking (DTS)	2.77	2.08	2.54
No of ear per plant (NEP)	0.004	0.018*	0.005
Ear length (EL)	1.24	1.51	1.38
Ear diameter (ED)	5.67	14.46*	4.62
No of Grain row per Ear (NOGRPE)	1.63	0.53	0.76
No of Grains per Row (NOGPR)	13.01	12.21	7.65
1000 of Grain weight (THOGW)	0.0012	0.00056*	0.00025
Field weight in tons per hectare	6.09	3.27	1.74
Grains yield per plot (GYPPT)	0.0024	0.05	0.02
Grains yield in tons per hectare	0.12	2.39*	0.73
AGBYPP	1.38	0.60	0.42
AGBYTPH	61.19	26.70	18.50
Harvest index (HI)	294.23	107.62	127.75

* = Significant at 5% level of significance, ** = Significant at 1% level of significance, AGBYPP = above ground biomass yield per Plot, AGBYTPHA = above ground biomass yield in tons per hectare.

Traits	**PCV**	**GCV**	**$б^2g$**	**$б^2p$**	**$б^2e$**	**Hbs**	**GA**	**GA as % of mean**
No. of leaves (NL)	6.34	1.54	0.04	0.69	0.65	6.00	0.10	0.77
Plant height (PH)	22.21	7.57	162.67	1398.66	1561.28	12.00	8.96	5.32
Ear Height (EH)	12.21	5.30	21.32	109.17	87.85	11.00	1.23	1.51
Leaf length (LL)	6.59	2.19	3.25	29.29	26.04	11.00	1.23	1.51

Leaf width (LW)	8.16	3.62	0.09	0.45	0.54	20.00	0.27	3.31
Leaf Area (LA)	13.57	3.38	294.18	4755.11	5049.29	6.00	8.79	1.73
Number of tassel branches (NTB)	15.95	8.61	2.22	7.61	5.39	29.00	1.66	9.58
Stem Diameter (SD)	10.93	2.61	0.22	3.92	4.14	6.00	0.23	1.29
Days to 50% anthesis (DTA)	4.14	1.45	0.50	4.09	3.59	12.00	0.51	1.05
Days to 50% silking (DTS)	2.97	0.75	0.15	2.38	2.54	6.00	0.20	0.39
No of ear per plant (NEP)	9.19	6.16	0.004	0.009	0.005	45.00	0.09	0.09
Ear length (EL)	7.83	1.35	0.42	1.43	1.38	3.00	0.07	0.48
Ear diameter (ED)	6.37	4.88	3.28	7.90	4.62	42.00	2.40	5.45
No of Grain row per Ear (NOGRPE)	6.14	2.06	0.08	0.69	0.76	11.00	0.19	1.42
No of Grains per Row (NOGPR)	9.78	3.98	1.52	9.17	7.65	17.00	1.03	3.34
1000 of Grain weight (THOGW)	5.82	2.91	1.51	4.51	3.51	25.00	0.01	3.00
Field weight in tons per hectare	12.71	6.05	0.51	2.25	1.74	23.00	0.71	5.94
Grains yield per plot (GYPPT)	12.69	8.35	0.010	0.03	0.02	43.00	0.15	11.30
Grains yield in tons per hectare	13.10	8.57	0.55	1.28	0.73	43.00	1.00	11.56
AGBYPP	23.35	8.38	0.06	0.47	0.42	12.00	0.18	6.19
AGBYTPH	23.35	8.37	2.73	21.80	18.50	13.00	1.22	6.19
Harvest index (HI)	24.27	5.71	6.71	121.04	127.75	5.00	1.26	2.77

Table 2: Estimation of PCV, GCV, Heritability, Genetic Advance, Phenotypic Variance, Genotypic Variance, for Growth, Yield and its attributing traits of Ten Maize Genotypes.

σ^2g = Genotypic variance, σ^2p = Phenotypic variance and σ^2e = Environmental variance, Hbs=Heritability broad sense, GCV=Genotypic coefficient of variation, PCV= Phenotypic coefficient of variation, GA = Genetic advance, GAM =Genetic advance as percent of mean. AGBYPP = above ground biomass yield per plot (Kg).

Table 3: Mean Performance for Twenty-two (22) Traits of Maize Genotypes.

VARIETIES	NL	PH	EH	LL	LW	LA	NTB	SD	DTA	DTS	NEP	EL	ED	NOGRPE	NOGPR	THOGW	FWTPH
SAMMAZ 51	13.73[a]	129.67[a]	85.40[ab]	81.87[ab]	8.13[a]	502.27[a]	14.67[a]	17.28[a]	49.73[a]	52.73[a]	1.03[b]	15.53[a]	46.14[abc]	13.60[a]	32.53[ab]	0.34[abc]	13.16[ab]
SAMMAZ 53	13.53[ab]	149.73[a]	90.73[ab]	86.60[ab]	8.50[a]	552.38[a]	17.67[ab]	18.79[a]	46.93[b]	51.13[a]	1.10[b]	14.78[a]	42.60[bcd]	13.67[a]	29.57[ab]	0.34[abc]	11.06[bc]
SAMMAZ 15	13.53[ab]	166.13[a]	79.8[ab]	83.10[ab]	8.12[a]	508.51[a]	16.00[b]	17.14[a]	51.07[a]	52.27[a]	1.00[b]	15.68[a]	44.89[abcd]	13.46[a]	33.57[a]	0.33[bc]	11.30[bc]
SAMMAZ 18	13.27[ab]	183.93[a]	85.20[ab]	83.80[ab]	8.53[a]	536.74[a]	19.07[ab]	18.39[a]	49.33[ab]	53.40[a]	1.10[b]	15.62[a]	44.49[abcd]	13.87[ab]	30.63[ab]	0.35[abc]	11.68[abc]
SAMMAZ 55	13.20[ab]	183.73[a]	93.33[ab]	82.30[ab]	8.51[a]	528.89[a]	14.60[b]	19.97[a]	40.03[ab]	51.80[a]	1.03[b]	15.15[a]	40.83[d]	13.00[a]	31.32[ab]	0.36[ab]	12.02[abc]
SAMMAZ 29	13.00[ab]	179.87[a]	91.40[ab]	81.13[ab]	7.9 [a]	485.63[a]	20.93[a]	17.57[a]	47.07[b]	50.47[a]	1.33[b]	14.06[a]	47.69[a]	14.40[a]	29.10[ab]	0.34[abc]	11.10[bc]
OBA 98	12.87[ab]	193.80[a]	96.95[a]	87.93[a]	8.40[a]	55.18[a]	18.80[ab]	19.21[a]	50.13[ab]	51.60[a]	1.27[a]	16.05[a]	46.14[ab]	13.47[a]	34.00[a]	0.37[a]	13.97[a]
SAMMAZ 54	12.80[ab]	173.27[a]	93.00[ab]	81.20[ab]	8.34[a]	507.96[a]	16.13[b]	18.86[ab]	49.07[ab]	52.53[a]	1.03[a]	14.18[a]	40.50[bcd]	13.13[a]	28.98[b]	0.34[abc]	10.51[c]
SAMMAZ 17	12.73[ab]	164.03[a]	76.13[b]	77.93[ab]	7.84[a]	460.34[a]	17.47[ab]	16.75[a]	48.60[ab]	51.80[a]	1.03[a]	15.53[a]	43.19[bcd]	13.40[a]	31.70[ab]	0.34[bc]	11.97[abc]
SAMMAZ 52	12.00[b]	160.00[a]	78.53[ab]	76.60[a]	7.68[a]	442.90[a]	17.67[ab]	17.18[a]	28.53[ab]	51.73[a]	1.03[b]	15.53[a]	42.10[cd]	13.03[a]	28.98[ab]	0.32[c]	11.26[bc]
S.E	0.804	39.513	9.372	5.102	0.732	71.057	2.321	2.034	1.894	1.592	0.073	1.179	2.150	0.874	2.766	0.015	1.317

NL = Number of leaves, DTA= Days to 50% anthesis, DTS= Days to 50% Silking, PH= Plant height, ED = Ear Diameter, NEP = number of ear per plant, (cm), EH= Ear height (cm), LL= Leaf length (cm), LW= Leaf width, LA = Leaf Area NTB = Number of tassel branches, EL= Ear length (cm), ED= Ear diameter (cm), NOGRPE= Number of grain rows per ears, NOGPR = number of grain per row. THOGW = 1000 grain weight, FWTHA = Field weight ton per hectare.

Table 3. cont…

	TRAITS				
VARIETIES	**GYPP**	**GYTPHA**	**AGBYPP**	**AGBYTPHA**	**HI**
SAMMAZ 51	1.50[a]	9.97[a]	3.63[a]	20.67[a]	47.33[a]
SAMMAZ 53	1.30[abc]	8.63[abc]	3.02[a]	16.62[a]	45.83[a]
SAMMAZ 15	1.12[c]	7.45[c]	2.83[a]	19.34[a]	43.33[a]
SAMMAZ 18	1.19[bc]	7.95[bc]	3.60[a]	20.67[a]	43.17[a]
SAMMAZ 55	1.36[ab]	9.07[bc]	2.80[a]	14.80[a]	49.67[a]
SAMMAZ 29	1.30[abc]	8.66[abc]	2.54[a]	14.56[a]	48.83[a]
OBA 98	1.50[a]	9.90[a]	3.43[a]	17.8[a]	47.00[a]
SAMMAZ 54	1.17[bc]	7.61[bc]	2.54[a]	14.41[a]	50.50[a]
SAMMAZ 17	1.38[ab]	9.22[a]	2.42[a]	14.61[a]	55.00[a]
SAMMAZ 52	1.21[a]	8.07[bc]	2.78[a]	15.42[a]	50.67[a]
S.E	0.124	0.8571	0.645	4.300	11.30

GYPP = Grain yield per plot, GYTPHA = Grain yield in tons per hectare, AGBYPP = above ground biomass yield per Plot, AGBYTPHA = above ground biomass yield in tons per hectare, HI = Harvest index.

Table 4: Path Coefficient Analysis Showing Direct (diagonal bold) and Indirect (off diagonal) Effect on the Harvest Index at Genotypic Level in Maize Genotypes.

TRAITS	PH	NTB	DTA	DTS	NEP	EL	ED	NOGRE	NOGR	THOGW	GYPLOT	AGBYHAkgha	**Genotypic correlation with HI**
PH	**-0.506**	0.116	-0.001	-0.207	-0.138	0.008	-0.214	0.053	-0.478	0.401	-0.127	-0.463	-1.240
NTB	0.259	**0.228**	-0.020	-0.174	-0.118	0.013	-0.765	0.220	0.104	1.030	0.384	0.261	1.098
DTA	-0.006	-0.099	**0.046**	0.325	0.013	-0.041	-0.908	0.157	0.193	1.028	-0.767	-0.100	0.313
DTS	-0.585	-0.221	0.084	**-0.179**	0.147	0.001	0.455	0.078	0.096	1.035	0.815	0.189	-0.193
NEP	0.552	0.212	-0.004	-0.207	**-0.127**	0.001	-0.942	-0.118	0.172	0.574	1.457	0.484	0.903
EL	-0.597	-0.430	0.271	-0.019	0.017	**-0.007**	0.437	-0.087	0.222	1.283	1.919	0.627	0.903
ED	0.105	0.170	0.041	-0.079	-0.116	0.003	**-1.026**	0.273	0.185	-0.110	1.125	1.005	1.194
NOGRE	0.447	0.249	0.010	-0.022	-0.136	0.023	-0.985	**-0.249**	0.099	-0.290	0.638	0.387	0.465
NOGR	-0.199	-0.158	0.093	0.197	-0.043	-0.015	-0.661	-0.092	**-0.267**	0.544	-0.724	-0.379	-0.159
THOGW	0.833	-0.040	0.011	-0.024	-0.121	-0.001	-0.053	-0.115	-0.232	**0.626**	-2.344	-1.176	0.018
GYPLOT	-0.075	-0.099	0.007	-0.060	-0.061	0.001	-0.402	-0.061	-0.074	0.566	**-2.592**	-0.289	1.244
AGBYHAkgha	-0.221	-0.383	0.131	0.570	-0.051	0.002	0.274	-0.162	-0.169	1.232	-1.256	**0.597**	2.810

* And ** highly significant and significant at 1% 5%, respectively. DTA= Days to 50% anthesis, DTS= Days to 50% Silking, PH= Plant height (cm), NTB = Number of tassel branches, EL= Ear length (cm), ED= Ear diameter (cm), NGRPE= Number of grain rows per ears, NGPR= Number of grain per row, THOGW= Thousands of grain weight (kg), GYPLOT= Grain yield per plot, AGBYHAkgha= Above ground biomass yield per hectare (kg), HI= Harvest index.