MULTIVARIATE ASSESSMENT OF VARIATIONS IN YIELD AND YIELD COMPONENTS OF MAIZE (*Zea mays L.*)

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Abstract
Twenty accessions of maize (*Zea mays L.)* were evaluated for yield and yield components in order to identify the components that contribute mostly to the variation in yield of maize;and to classify and partition them into groups for better use and management of the accessions. The study was conducted at the Teaching and Research farm of the Federal University of Technology, Owerri, Nigeria, during the 2011 and 2012 cropping season. Maize accessions from Southeastern Nigeria were evaluated in a randomized complete block design with three replications. Data collected were subjected to analysis of variance. Principal component analysis (PCA) and cluster analysis were employed to analyze the variation patterns in these accessions. Variance component analysis showed significant variation in both environmental and genotypic effect in all the yield related traits.The results showed that cluster five (v) gave the highest proportion of 40% while cluster four (iv) gave the least proportion of 5%. The result of the principal component analysis (PCA) showed that principal component 1 (PC1) axis had the highest loading for ear weight (0.99116),while the PC2 and PC3 had highest loadings for ear height (0.68986) and (0.70851), respectively.
Keywords: Variability, Genotype, Yield components, *Zea mays L.*

Introduction

Maize (*Zea mays* L.) belongs to the family *Poaceae*. Maize is the third most important cereal crop in the world along with an important source of carbohydrates. Thiscrop also serves as sources of income to small and large scale farmers in developing countries (Ahmed and Yusuf, 2007).Maize is a multipurpose crop used for food, feed, fodder and several industrial products. About two third of the total world production of maize is used for livestock feed or for commercial starch and oil production. It has a great nutritional value as it contains about 66.7% starch, 10% protein, 4.8% oil, 8.5% fiber,3% sugar and 7% ash (Chaudhry, 1983).

The success of any crop improvement through breeding depends largely on the available genetic variability within the crop species. Analysis of genetic relationships in crop species is an important component in crop improvement programs, as it provides information about genetic diversity (Mohammadi and Prasanna, 2003) and sources of genetic variation for plant breeding programs.

Multivariate analysis has been used extensively in summarizing and describing inherent variations in population of crop genotypes (Ariyo, 1993) and for the classification of yield and seed quality in crop genotypes (Akoroda, 1983, Okelola, 2005, Labuschangue*et al*., 2002).

Knowledge of multivariate studies will enhance better use and management of crop genotypes in crop improvement programmes. Literature on the use of multivariate analysis for discriminating within cultivated maize genotypes has been very limited.The study therefore was designed to identify the components that contribute mostly to the variation in the yield of maize and to classify and partition them into groups for better use and management of the accessions.

Materials and Methods

Twenty maize accessions were sourced from different locations of Southeastern Nigeria. The experiment was conducted at the Teaching and Research Farm of the Federal University of Technology, Owerri, Imo State, Nigeria in the 2011 and 2012 growing season, and was laid out in a randomized complete block design with three replications. The site is located in the humid tropics of Nigeria (latitude 5 27ˈ N and 7 02ˈ E). The annual rainfall is about 2500 mm and is bimodal with peaks in July and September. The area is characterized by daily minimum and maximum temperatures 20^{o}C and 32^{o}C, respectively. The soil is an ultisol characterized by deep porous red soils derived from sandy deposits in the coastal plane which are highly weathered, coarse textured, low in mineral reserve and natural fertility. (Eshet 1993, Onweremadu*et al*., 2007).

The land area used was 45m by 9.5m. One seed was planted per hole at an inter-row spacing of 0.25m and inter-row spacing of 0.75m giving a theoretical plant population of 53,333 plants per hectare.NPK 15-15-15 fertilizer was applied in two splits at the rate of 400kg per hectare. The first application was

after thinning at 3 weeks after planting, while the second application was at tasseling. Weed control on the plot was done manually using hoes, while Furadan 3G was used for pest control.
Data were collected on days to 50% emergence, days to 50% tasseling, days to 50% silking, ear height, ear weight, plant height at tasseling, 100 seed weight, and grain yield. Data collected from the two years were pooled as there were no significant differences between years, and were subjected to analysis of variance (ANOVA) to detect significant differences between treatment means (Obi, 1986). Fisher's least significant difference (F-LSD) was used for mean separation.Multivariate analysis consisting of the Principal component analysis and cluster analyisis were carried out using the GenStat Discovery Edition 3 (GenStat, 2007). Principal component analysis (PCA) was utilized to determine the extent of genetic variation in the accessions. The PCA produced an Eigenvector for each principal component axis. Cluster analysis was carried out according to Kozak and Kang (2007) to determine the extent of relationship among the genotpes.

Results and Discussions

Results in Table1 show that there were no significant differences in plant height, days to 50% emergence and days to 50% silking but there were significant differences in Days to 50% tasseling, ear weight, ear height, hundred seed weight and grain yield.The significant differences observed indicates the existence of substantial variability among the accessions, hence a scope for improvement through selection. The variability of some of the traits of the accessions may be attributed to their genetic makeup and higher adaptation of some accessions to the prevailing environmental conditions. Similar result was reported by Miti*et al,* (2010), which indicated that selection for better performance of maize varieties could be based on its inherent ability to tolerate the prevailing abiotic factors within the period of growth and development.

Table 1: Mean squares of the quantitative traits evaluated in the maize accessions

Source of variation	df	Plant height (m)	Days to 50% silking	Days to 50% emergence	Days to 50% tasseling	Ear weight (g)	Ear height (cm)	100 seed weight	Grain yield (t/ha)
Block	2	2.98	154.72	0.61	216.02	5798.2	96.26	376.56	7.32
Accession	19	0.09	53.67	0.64	50.99**	4819.70**	9.17**	49.25**	0.77**
Error	38	0.08	35.26	0.67	12.56	374.50	2.83	8.25	0.30

Results in Table 2 show the cluster means of the agronomic and yield characters of the maize accessions. Cluster five gave the highest proportion (40%) while cluster four gave the least proportion (5%).The intra-population variability evaluated by hierarchical cluster analysis conducted on the traits, grouped the accessions into five clusters, indicating sufficient heritable variation that could warrant rational selection.

Table 2: Cluster means of agronomic and yield characters of the maize accessions

Characters	I	II	III	IV	V
100 seed weight(g)	21.24	21.47	22.87	13.80	14.80
Days to 50% silking	46.20	44.80	47.30	50.40	46.30
Days to 50% tasseling	38.67	36.75	40.17	42.33	40.67
Days to physiological maturity	114.10	107.10	113.30	111.50	110.90
Ear weight(g)	115.50	97.20	93.80	83.60	55.40
Plant height at tasseling	1.94	1.92	1.67	1.31	1.30
Grain yield (t/ha)	2.38	2.32	2.33	2.24	2.06
Ear height(cm)	95.10	87.80	93.60	91.10	87.80
Number of grains/row	26.90	22.30	22.60	21.50	22.30
Tasselling-silking interval	6.65	7.33	7.11	8.36	7.96
Days to 50% emergence	7.00	6.80	6.60	7.20	6.80
Number of rows/ear	13.88	12.78	12.43	11.71	10.99
Proportion (%)	30.00	10.00	15.00	5.00	40.00

Consequently, principal component analysis describes the pattern of co-variation of characters among individuals. The results of the principal component analysis (PCA) presented in table 3 shows that the first, second, third and fourth components contributed 99.01% of the variability among the accessions evaluated. The PC1, PC2 PC3 and PC4 accounted for 89.71%, 4.00%, 3.83% and 1.47% of the total variation, respectively. The PC1 axis had a very high loading for ear weight (0.99116), while the PC2 axis and PC3 axis had very high loadings for ear height (0.68986) and (0.70851), respectively. These axes could therefore be seen as productive and yield axes since it is highly loaded for yield component parameters (ear weight and ear height).

Table 3: Eigen vectors and percentage variation for principal components (PC1), (PC2), (PC3) and (PC4) of twenty maize accessions

Characters	PC1	PC2	PC3	PC4
100 -seed weight (g)	-0.035	0.15113	0.04606	-0.42064
Days to 50% tasseling	-0.04085	0.16777	-0.11193	0.59412
Days to 50% emergence	-0.00458	0.00918	-0.00004	0.03522
Days to 50% silking	-0.00883	0.11849	-0.21876	0.64345
Days to physiological maturity	-0.11297	0.66556	-0.65322	-0.22582
Ear height (cm)	-0.02574	0.68986	0.70851	0.05612
Ear weight (g)	0.99116	-0.10935	0.06185	0.00888
Grain yield (t/ha)	-0.00508	0.00564	0.00388	0.01696
Plant height at tasseling	-0.00052	-0.00720	0.00535	0.01732
Tasseling-silking interval	0.03367	-0.06304	-0.07030	0.00139
Percentage variation (%)	89.71	4.00	3.83	1.47

Figure 1 shows the first and second principal component scores of the twenty maize accessions and distribution in the clusters .Six of the accessions fell into cluster 1, two of the accessions fell into cluster 2, 3 fell into cluster 3 while eight of the accessions fell into cluster 4 .The distribution of the accessions along the two principal component axes revealed a reasonable agreement with the hierarchical cluster. However, the fact that the accessions did not cluster together either on the basis of place of collection or grain type/colour, suggests that many of them are probably ecotypes, which have become adapted to the different localities, having remained with the farmers for a long time. This observation agrees with the reports of the previous authors (Hoxha*etal*., 2004 and Kostova*etal*., 2006), who noted that morphological characteristics are often influenced by the environment and therefore do not always express genetic relationships.

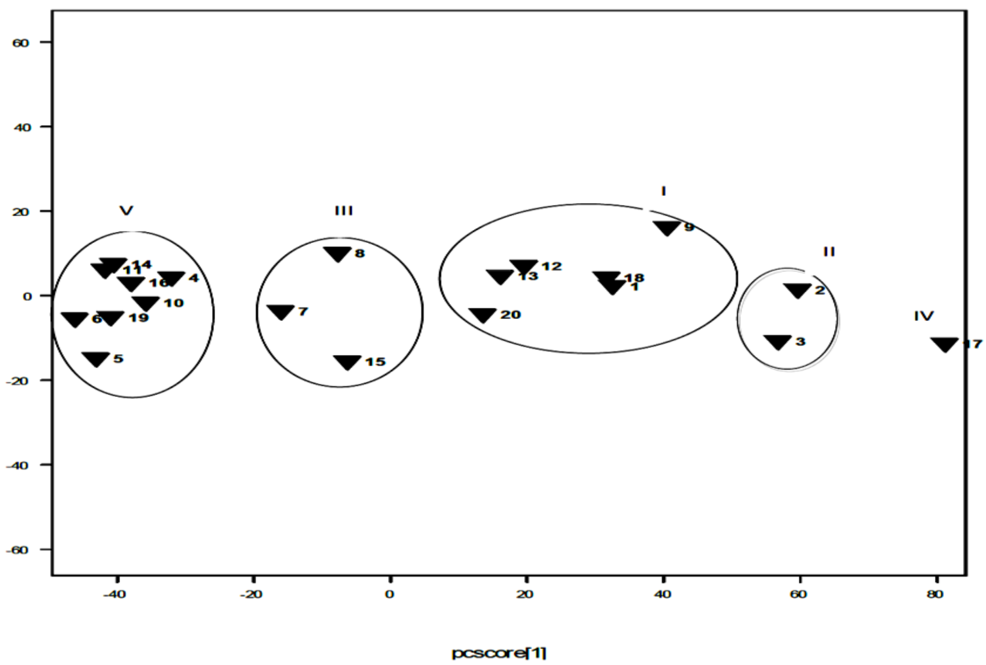

Figure 1: First and second princpal component scores(PC1) and (PC2) for the identification of the performance of twenty maize accessions

Conclusion

Mean performance of the accessions indicated significant (P=0.05) variation among the accessions in tasseling time, ear height, ear weight, 100 seed weight and grain yield, but showed no significant differences in days to plant emergence, plant height at tasseling and days to 50% silking. This suggests a high level of genetic variability among the accessions, which are desirable for effective selection.The results of the cluster means of the agronomic and yield related characters of the twenty accessions show that cluster five (v) gave the highest proportion of 40% while cluster four (iv) gave the least proportion of 5% which indicates a sufficient heritable variation for selection.The result of the principal component analysis (PCA) show that the first, second, third and fourth components contributed 99.01% of the variability with PC1, PC2, PC3 and PC4 accounting for 89.71%, 4.00%, 3.83% and 1.47% of the total variation respectively. The PC1 axis had a very high loading for ear weight (0.99418), while the PC2 and PC3 had very high loadings for ear height (0.68986) and (0.70851) respectively and could therefore be seen as productive and yield axes.

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