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Numerical analysis of variation among accessions of West African okra *Abelmoschuscaillei (a. chev) stevel)*

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Abstract

Nineteen quantitative characters were observed on 14 accessions of West African Okra. Principal Component Analysis (PCA) and Complete Linkage Cluster Analysis (CLCA) were employed to analyses the variation pattern in these accessions. The first three principal components accounted for 68.47% of the total variation. Using character variation, complete linkage cluster analysis summarized the position of accessions into a dendrogram at interval of 5% level of similarity, while the accessions were sorted into five distinct groups.

Key words: Okra; Variation; Cluster analysis; Accessions

1. Introduction

In self – pollinated crops such as Okra, germplasm often exist in the form of homozygous genotypes, which could be released as varieties in the short run, for long – term improvement; however, diverse genotypes are needed as parental stocks for the development of improved varieties. In addition, it is important to classify the range of variability among accessions to facilitate the maintenance and further acquisition of germplasm resources (Ariyo and Odulaja, 1991).

Development of improved varieties of crop plants necessarily involves the incorporation of specific gene complexes governing desired traits. Plant breeders firstly identify traits in plant species that make them suitable for utilization by man, then search out new genes for the desired traits before combining the genes for desired traits in new cultivars (or strains) using traditional breeding techniques of biotechnology. They then finally assess the performance of the new cultivars before releasing them as registered cultivars to be grown widely by farmers and enjoyed by customers. Thus the wealth of any germplasm collection is measured in terms of the genetic variability of the crop species it contains. Many techniques have been employed by researchers to determine the extent of variability in germplasm collection. The Principal Component Analysis (PCA) has been used to measure genetic divergence among genotypes. Principal Component Analysis, a common ordination numerical techniques, reduces the dimensions of multivariate data by removing inter-correlations among attribute – variables (characters on which units are to be compared) and enables multidimensional relationships to be plotted on two or three principal axes, which are minimally correlated and represents linear combinations of the original characters (Clifford and Stephenson, 1975; and Akoroda, 1983). The relatively discriminating power of axes and their associated characters are measured by eigen values and factor scores respectively. The first principal component analysis accounts for much of the variability in the data and each succeeding component accounts for as much of the remaining variability as possible.

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A complete linkage cluster analysis (CLCA) is an agglomerative technique, which shows the pattern of relationship between individuals of a population. Cluster analysis is generally employed to sort individuals into distinct groups. Detailed accounts of cluster analysis are given by Sokal and Sneath (1963). The aim of the study was to identify the major characters responsible for the variation and possibility of hybridization among the accessions as well as to classify the variation pattern within the germplasm collection.

2. Material and methods

Fourteen accessions of West African Okra *Abelmoschuscaillei*(A. Chev) Stevel utilized in this research were obtained from the germplasm collection of the University of Agriculture, Abeokuta. The field evaluation of these accessions was carried out at the Teaching and Research farm, University of Agriculture, Abeokuta. (Lat 7.35^0N, 3.88^0E, 450m asl) during the late rainy season of September, 2003. The origin and sources of these accessions are presented in table 1. A single row plot was adopted for the study in a Randomized Complete Block Design (RCBD) with three replications; each plot has a length of 16 meters and inter-row measurement of 1.0 meter. Two seeds of each accession were planted per hole with intra-row measurement of 1m and later thinned to 1 plant/stand. A total of sixteen (16) plants were maintained per row. Manual weeding was carried out as necessary. A pyrethoid insecticide (Karate EC) was sprayed at flowering/budding stage at the rate of 40m/s/20litres of water during the experiment against insect pests. Each plot received a fertilizer equivalent N:P:K 15:15:15 at the rate of 60kg N/hectare at 3 weeks after planting and at flowering.

Table 1 West African Okra accessions used and their place of collection

Serial number	Accession name	Place of collection
1.	ACC 1	ASERO, Ogun State
2.	ACC 2	ABEOKUTA 3, Ogun State
3.	ACC 3	AMOKE – 3 BENUE
4.	ACC 4	ESTATE 1, Ogun State
5.	ACC 5	ISE, Ekiti State
6.	ACC 6	ISOLU, Abeokuta
7.	ACC 7	IKENE 1, Ogun State
8	ACC 8	ABEOKUTA 2, Ogun State
9.	ACC 9	IKENE 2, Ogun State
10.	ACC 10	IKENE 3, Ogun State
11.	ACC 11	IBADAN 3, Oyo State
12.	ACC 12	IBADAN 2, Oyo State
13.	ACC 13	IBADAN 4, Oyo State
14.	ACC 14	ABEOKUTA 4, Ogun State

Cluster analysis was performed according to Ward (1963) by GENSTAT computer program (Genstat 1993) at the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria. A similarity matrix was developed from the data matrix by comparing each accession with every other one. Principal Component Analysis produced an eigen vector for each principal axis. The character loadings were used to determine the accession component scores. Using the character variation, complete linkage cluster analysis summarized the position accessions into dendogram at intervals of 5% level of similarity.

3. Results

Principal component analysis (PCA) produced an eigen vector for each principal component axis. Only three of the nineteen (19) principal component axes had eigen values greater than 2.0 and altogether accounted for 68.47% of the total variation (Table 2). All other characters accounted for less proportion of the variation. The first two principal axes accounted for 56.91% of the total variation among the nineteen (19) characters that described the fourteen (14)

accessions. The PCA axes showed that PCA1, PCA2 and PCA3 accounted for 41.32%, 15.58% and 11.56% of variation, respectively.

The scores of the major characters describing the first three principal axes are presented in table 3. The arithmetic sign of the coefficient is irrelevant since a common rule of thumb for determining the significance of a character coefficient is to treat coefficient greater than 0.3 as having a large effect to be considered important Raji (2002). Characters having less than 0.2 coefficient value were considered to be of no effect to the over-all variation observed in the study. The first principal component which accounted for the highest proportion (41%) was mostly correlated with characters such as seed weight, pod yield, number of pods per branch and branch length. The characters mostly correlated with the second principal component were number of ridges per pod and edible pod width.

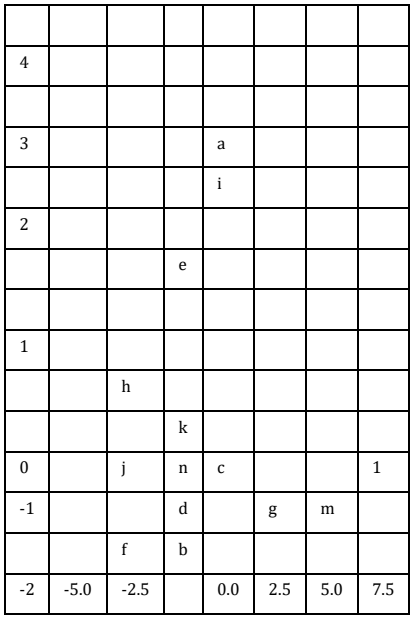
Table 2 Eigen values and percentage of total variation accounted for by 19 principal component axes of the ordination of west african okra (*abelmoschuscaillei* (a. Chev) stevel

Principal Component Axis	Eigen – Value	Total Variation accounted for (%)	Cumulative Percentage
1.	7.85	41.32	41.32
2.	2.26	15.58	56.91
3.	2.20	11.56	68.47
4.	1.67	08.81	77.27
5.	1.48	07.79	85.06
6.	1.11	05.85	90.91
7.	0.86	04.55	95.46
8	0.34	01.82	97.28
9.	0.22	01.16	98.45
10.	0.11	00.57	99.02
11.	0.09	00.47	99.48
12.	0.06	00.36	99.84
13.	0.03	00.16	100.00

Table 3 Scores of major characters of the first three principal components used in ordination

Characters	**Axis 1**
Seed weight	0.3132
Pod yield	0.3054
Number of pods per Branch	0.3186
Branch length	0.3086
Number of pods per	0.2790
Characters	**Axis 2**
Number of ridges per pod	0.3966
Edible pod width	-0.5044
Edible pod length	-0.2607
Characters	**Axis 3**
Number branches per Plant	0.3319
Number of days to Maturity	0.4177
Number of days to flowering	0.4130
100 seed weight	0.4676
Height at flowering Plant	0.2887

Axis 3



a =acc 1, b =acc2, c =acc 3, d =acc 4, e =acc 5, f =acc6, g =acc7, h =acc 8, i =acc 9, j =acc 10, k =acc 11, l =acc 12, m =acc 13 & n =acc 14

Figure 1 The distribution of the 14 accessions of West African Okra plotted on axes 1 & 3

Table 4 Major characteristic pattern of five groups of Okra accessions *(A caillei)* showing mean values

	Groups of accessions				
Descriptor	1 1, 3, 11, 9, 14	2 7, 13	3 2, 5, 4, 6	4 8, 10	5 12
Seed weight	15.90	68.85	14.28	12.60	48.30
Pod yield	30.88	134.85	21.68	27.60	110.50
Number of pods per branch	3.30	3.50	2.60	3.00	5.00
Number of branches per plant	2.72	4.15	2.43	3.00	4.70
Mature pod length	7.30	8.50	7.75	7.35	10.30
Edible pod length	6.25	5.50	5.95	5.50	7.00
Number of days to maturity	108.00	98.50	110.00	115.50	80.00
Number of ridges per pod	7.10	7.00	6.40	8.00	6.70
Number of seeds per ridge	9.20	10.35	8.25	8.50	10.70
Number of seeds per pod	65.00	69.00	56.75	65.50	72.00
Peduncle length	4.50	5.00	4.10	4.50	7.70
Branch length	29.14	45.40	27.68	10.50	56.00
Height at first flowering	75.00	70.00	53.50	39.00	55.70
Height at maturity	105.00	133.00	89.25	44.50	113.00
Number of days to first flowering	85.00	70.50	81.25	99.50	63.00
Edible pod width	4.00	3.70	3.95	3.50	3.70
100 seed weight	4.40	4.30	4.20	3.70	4.30
Mature pod width	6.40	6.15	6.13	6.00	7.30
Number of pods per plant	16.00	35.80	14.60	13.50	25.00

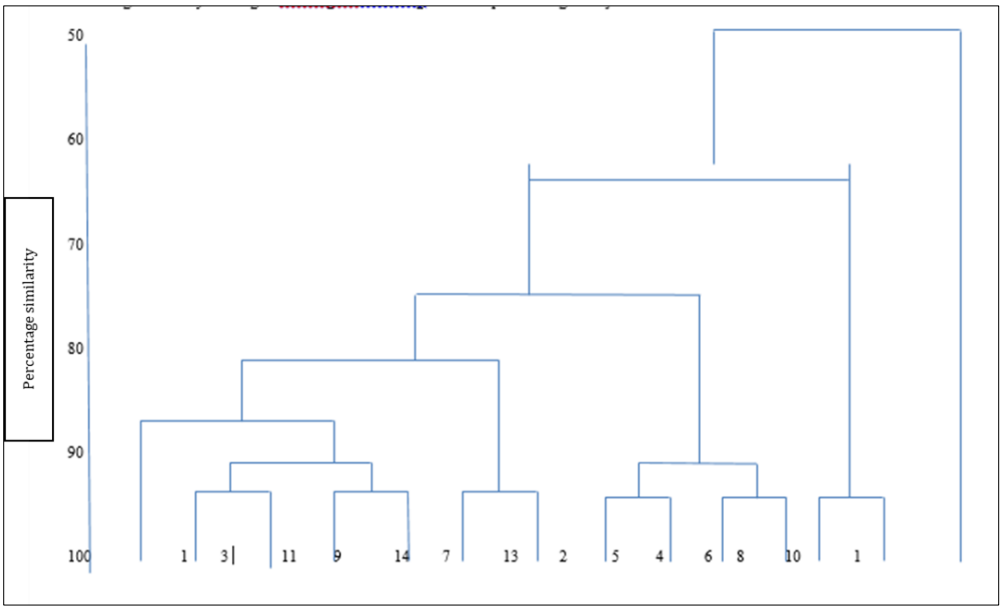


Figure 2 Dendrogram resulting from complete linkage analysis of 14 accessions of West African Okra

The third principal component was dominated by characters that are mostly physiological such as number of branches per plant, number of days to maturity, number of days to first flowering and 100 seed weight (Table 3). Based on the first and third axes, a two-dimensional ordination of the accessions was drawn (Fig 1). A plot of accessions on axes 1 & 3 (Fig 1) showed that accession 12 was the most distinct from all other accessions.

Figure 2. Showed the dengrogram drawn from complete linkage cluster analysis to illustrate the relationship between the14 accessions of West African Okra evaluated in the study. At 100% level of similarity, all the 14 accessions were distinct from each other. Accessions 1, 3, 11, 9 and 14 all formed a single cluster at 92% level of similarity. In addition, accessions 7 and 13 had been joined to accessions 1, 3, 11, 9 and 14 at 90%. However, at 80% level of similarity, 8 and 10 were most similar. Figure 2 also showed that at 75% level, accession 12 could be distinguished from the rest of the population, at 75% level all had formed a single cluster indicating that each accession had at least one neighbour with more than 75% similarity. In all, the accessions were classified into five distinct groups. Group I has five accessions, group II has two accessions while group III has four accession, and group IV has two accessions while group V has only one accession.

4. Discussion

The result from the Principal Component Analysis (PCA) identified three axes to have accounted for 68.44% of the 100% variation in the 14 accessions of West African Okra (*(A.caillei* (A. Chev) Stevels) evaluated. The seed weight, pod yield, number of pods per branch, branch length and number of pods per plant were identified as major factors to have contributed 41% of variation in PCA1. Based on the first and third principal axes, a two dimensional ordination of the accessions was drawn, grouping the 14 accessions of West African Okra evaluated in this study. One basic assumption in the use of numerical analysis is that numerical evaluation of overall similarity between accessions is a measure of genetic similarity Sokal and Sneath (1963). The complete linkage cluster analysis revealed a range of genetic diversity among the accessions. It is significant that accession 12 formed a distinct cluster.

It would be suitable to use quantitative characters most especially number of days to maturity and number of days to flowering as criteria for grouping these accessions since number of days is always correlated with life span Ariyo and Odulaja (1991). The importance of flowering behavior in numerical taxonomic studies has already been highlighted by Sokal and Sneath (1963). Accession 12 is the only early maturing accession and becomes an obvious parent for hybridization whenever breeding for early maturity is the object. Classification of accessions into separate distinct clusters indicates that hybridization of West African Okra accessions across clusters could lead to increase in heterotic effect for most characters and this is mostly evident between cluster 5 and cluster 2.

5. Conclusion

The seed weight, pod yield, number of pods per branch are the major traits contributing to the variation observed in the experiment thereby needed to be considered in the future breeding programmes of West African okra. The study showed a lot of genetic diversity among the accessions thereby brings about hopes of possible improvement of West Africa okra.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

All authors declare that no conflict of interest is exist.

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