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Morphological Variability of *Cola acuminata* ((Pal. De Beauv) Schott and Endl.) Germplasm in Cameroon

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Abstract: Seventeen accessions of Cameroonian *Cola acuminata* germplasm were evaluated to examine the variation based on 17 morphological traits in order to establish a list of minimum descriptors for characterization, to determine morphotypes and formation of core collection. By using the statistical software package SPAD 4.1 and SPSS 10.1 for Windows, Principal Component Analysis (PCA), Multiple Component Analysis (MCA) and Hierarchical Classification Ascendant (HCA) were carried out. All the descriptors studied have been included in the list of minimum descriptors for *Cola acuminata.* According to these descriptors, accessions can be distinguished in two morphotypes when the two phases of growth are taking into account. Makenene and Nkoteng accessions displayed the better growth whereas Mbang and Ngoulmakong displayed the weakest growth. These results of the Cameroonian accessions of *Cola acuminata* germplasm, could be utilised in breeding programmes after further evaluation and characterisation.

Key words: Accession, *Cola acuminata*, descriptors, morphotypes, variability

INTRODUCTION

The Global Action Plan for the Conservation and the Sustainable Use of Plant Genetic Resources (GPA) has among its high priority activities *ex situ* conservation. In addition, the GPA emphasizes the need for studies concerning characterization, evaluation and development of core collections, as these studies are important in the effective classification of the collections and allow the users to access their information needs (FAO, 1996).

The genus Cola is widely distributed in West and Central African countries. Among this genus, *Cola acuminata* is with *Cola nitida* the most important species according to their social, pharmacological and economical importance. With the increasing need of consumers for both quality and diversity of Cola products, there is a need to extensively collect, exploit and evaluate unknown Cola germplasm. Cola plays a key role in Cameroon and its improvement would enhance agricultural productivity and alleviate poverty. However, most of the Cola germplasm in the country is largely undocumented and has unknown morphological attributes. In the same way, *Cola acuminata* is a recalcitrant crop due to its long growth period. The first production takes place after 12 years and the tree can continue to produce until 70 at 100 years (Obeng and Brown, 1997). Sexual multiplication of plant provides the loss of elites genotypes due to allogame character of the plant (Oladokun, 1982).

Morphological parameters have been widely used in the evaluation of various crops (Rick and Holle, 1990; Weber and Wricke, 1994; Kaemer *et al*., 1995). Exploitation of such traits increases our knowledge of the genetic variability available and strongly facilitates breeding for wider geographic adaptability, with respect to biotic and abiotic stresses. In addition, genetic diversity needs to be described and measured if it is to be effectively incorporated into breeding strategies and management of plant genetic resources.

The objective of this study, therefore, was to examine the variation in *Cola acuminata* germplasm based on morphological traits in order to establish a list of minimum descriptors for characterization, to determine morphotypes for the formation of core collection.

MATERIALS AND METHODS

The present investigation was carried out in the field laboratory of the Department of Biological Sciences, High Teacher Training School, University of Yaounde I in Cameroon during the period from October 2002 to December 2004.

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Table 1: Passport of the accessions of *Cola* sp. studied

Species	No.	Name	Origin	Longitude	Latitude
Cola acumi	01	zoa	Zoaetele	11°53'	3°15'2"
nata	02	nkot	Nkoteng	112°1'2"	4°30'
	03	ombes	Ombessa	11°15'3"	4°36'
	04	okola	Okola	11°23'3"	4°1'1"
	05	bafia	Bafia	10°14'	4°45'
	06	mkne	Makenene	10°48'	4°53'
	07	elfmo	Elig-Mfomo	11°22'	4°11'
	08	mbsna	Mbangassina	11°24'	4°33'3"
	09	esse	Esse	11°53'	4°5'2"
	10	bokit	Bokito	11°6'4"	4°34'2"
	11	akonolinga	Akonolinga	12°16'	3°46'
	12	mbalmayo	Mbalmayo	11°30'	3°31'
	13	sangma	Sangmelima	11°48'	2°38'
	14	mbang	Mbang	NA	NA
	15	ngoulm	Ngoulmakong	NA	NA
	16	eseka	Eseka	NA	NA
	17	yde	Yaounde	11°24'	3°57'1

Table 2: Descriptors used in the accession characterization according to leaf and plantlets characteristics

Collar Diameter (CD)
Number of Leaf Appear (NLA)
Number of Secondary Stems (NSS)
Leaf Surface (LS)
Petiole Length (PL)
Limb Length (LL)
Limb Width (LW)
Leaf Total Length (LTL)
Petiole Leaf Insertion Diameter (PLID)
Petiole Stem Insertion Diameter (PSID)
Number of Secondary Ribs (NSR)
Number of Between-Knots (NBK)
Plant Height (PH)
Colour of Lower Limb (CLW)
Colour of Upper Limb (CUL)
Colour of Median Petiole (CMP)
Colour of Petiole Junction Pattern (lower) (CPL)
Colour of Petiole Junction Pattern (upper) (CUP)
Colour of Petiole of Leaf Junction (lower) (CPLJ)
Colour of Petiole of Leaf Junction (upper) (CPUJ)

Materials: Seeds of seventeen accessions of *Cola acuminata,* harvested in different localities in the old traditional landraces on trees of at least 10 years old (Table 1) were used. Each accession was kept *ex situ* in a plot. The planting distance was 0.90 m between rows and 0.35 m between plants in row.

Morphological traits: Two phases of growth have been considered during a period of two years: phase I of twelve months old from germination and phase II with the same duration intervening at the end of the first.

Twenty morphologic descriptors (13 quantitative and 7 qualitative) were used to evaluate leaf and plantlets characteristics (Table 2). Some of these characteristics and modalities used were those reported by IPGRI (IPGRI, 1999).

Statistical analysis: Descriptors that contributed most to variability were determined on the basis of those original variables with greater influence on the components according to the following approach: the mean value from the highest and lowest eigenvectors were used as the threshold for selection of the most contributing variables (Fundura *et al.*, 1992).

By using the statistical software package SPAD 4.1 for Windows, Principal Component Analysis (PCA) and Multiple Component Analysis (MCA) were carried out, starting from a standardised correlation matrix. Hierarchical Classification Ascendant (HCA) using the statistical software package SPSS 10.1 for Windows was carried out to separate *Cola acuminata* accessions in different groups according to the morphological descriptors studied.

RESULTS AND DISCUSSION

Quantitative traits: High coefficients of variation are observed in all morphological characters of *Cola acuminata* and in every phase of growth indicating a large variation of accessions for these traits (Table 3a and b). All morphoquantitative descriptors studied are then discriminant for the identification of *Cola acuminata* accessions. Similar results were obtained by Morakinyo and Olorode (1984) who found that Limb length (LL) and Petiole length (PL) were minima descriptors distinguishing *Cola acuminata*, *Cola nitida* and their hybrid F1 (*Cola*

Table 3a: Descriptive statistics of *Cola acuminata* morphoquantitative characters (Phase I)

Eigenvectors	Means	Minimum	Maximum	SD	Variation	CV
CD	0.6	0.39	0.87	0.13	0.018	22
NLA	6.53	2	13	2.85	8.64	45
NSS	0.71	0.0	2	0.57	0.34	83.30
LS	56.30	27.33	115.89	20.41	4.40	37.40
PL	2.84	1.20	5.11	0.91	0.88	32.20
LL	14.45	10.00	22.15	2.85	8.60	20.30
LW	5.74	3.80	8.55	1.25	1.60	22.50
LTL	17.04	11.90	24.40	2.95	9.23	17.80
PLID	0.32	0.26	0.32	0.04	0.00	11.90
PSID	0.34	0.26	0.44	0.05	0.00	14.70
NSR	15.18	9.00	21.00	3.50	13.02	23.80
PH	19.97	11.60	31.40	5.63	33.60	29.10
NBK	6.35	4.00	10.00	1.75	3.24	28.30

Table 3b: Descriptive statistics of *Cola acuminata* morphoquantitative characters (Phase II)

Eigenvectors	Means	SD	Minimum	Maximum	Variation	CV
CD	1.15	0.34	0.66	1.72	0.12	31
NLA	31.12	26.14	8.00	94.00	726	86.60
NSS	4.47	3.66	1.00	14.00	14.26	84.50
LS	72.04	18.60	42.93	107.50	3.60	26.60
PL	3.87	0.92	2.20	6.10	0.90	24.26
LL	16.22	2.59	11.06	22.50	7.12	16.50
LW	6.59	1.29	4.60	8.90	1.70	20.20
LTL	19.75	3.89	10.73	28.60	16	20.30
PLID	0.34	0.05	0.26	0.44	0.00	15.70
PSID	0.43	0.06	0.30	0.51	0.00	14.30
NSR	14.47	1.50	12.00	17.00	2.39	10.70
PH	33.82	12.46	13.70	60.50	1.65	38
NBK	10.35	2.99	6.00	17.00	9.49	29.80

Table 4a: Matrix of eigenvectors and values of the principal components for the quantitative characters (Phase I)

Principal components		CP1	CP2	CP3	CP4	CP5
Variance		5.63	2.22	1.55	1.40	1.07
% total contribution		43.32	17.13	11.93	10.83	8.26
% accumulated		43.32	60.45	72.38	83.21	91.47
Eigenvectors	CD	0.76	-0.38	-0.42	0.00	0.09
	NLA	-0.31	-0.81	0.01	-0.38	0.15
	NSS	-0.02	-0.53	-0.73	0.05	0.35
	LS	0.95	0.12	0.04	0.11	0.17
	PL	0.65	-0.13	0.16	0.25	-0.48
	LL	0.85	-0.21	0.35	0.11	0.20
	LW	0.86	0.37	-0.27	-0.01	0.02
	LTL	0.89	-0.22	0.32	0.12	0.10
	PLID	0.66	0.23	-0.28	-0.58	-0.10
	PSID	0.73	0.43	-0.25	-0.34	-0.07
	NSR	0.63	-0.64	0.19	0.23	-0.08
	PH	0.10	-0.31	0.42	-0.80	-0.17
	NBK	0.07	0.36	0.41	-0.11	0.75

Table 4b: Matrix of eigenvectors and values of the principal components for the quantitative characters (Phase II)

Principal components		CP1	CP2	CP3
Variance		4.66	3.20	2.33
% total contribution		35.85	24.64	17.96
% accumulated		35.85	60.49	78.45
Eigenvectors	CD	0.73	-0.31	-0.07
	NLA	0.83	-0.47	-0.09
	LS	0.39	0.84	-0.13
	NSS	0.83	-0.44	-0.04
	PL	0.54	0.56	0.19
	LL	0.56	0.66	0.44
	LW	0.03	0.61	-0.68
	LTL	0.63	0.64	0.31
	PLID	0.07	0.34	-0.86
	PSID	0.50	0.01	-0.67
	NSR	-0.20	0.44	0.53
	PH	0.83	-0.10	0.06
	NBK	0.78	-0.39	0.19

acuminata X *Cola nitida*). Thereafter, study of genetic variability of a collection of Nigerian *Cola nitida* germplasm allowed Adebola *et al.* (2002) to record 3 characters (number of follicles per tree, number of hands per tree and number of nuts per tree) as discriminant traits for the variability of the plant.

Several studies on morphological parameters in the identification of genetic diversity have been conducted for several crops. Chandran and Pandya (2000) noticed a wide variation of morphological traits in the morphological characterization of 35 accessions belonging to 13 species of *Arachis*. Furthermore, Jendoubi *et al.* (2001) defined leaf and flower characters as determinant in the variability of *Allium roseum* L.

According to the two phases of growth, NSS is amongst characters that displayed the highest coefficient of variation (CV) while PLID and NSR gathered the lowest CV in the phase I and II, respectively.

Principal components of variance superior to 1 give an evaluation of the percentage of the variability represented for every component and they are in general taken into account (Jeffer, 1967).

Table 5a: Matrix of eigenvectors and values of the principal components for the qualitative characters (Phase I)

Principal components		CP1	CP2	CP3
Variance		3.21	1.42	1.08
% total contribution		45.93	20.34	15.52
% accumulated		45.93	66.27	81.71
Eigenvectors	CLW	-0.38	0.26	-0.82
	CUL	-0.68	-0.05	-0.12
	CMP	-0.81	0.53	0.12
	CPL	-0.81	0.53	0.12
	CUP	-0.81	-0.37	0.39
	CPLJ	-0.36	-0.56	0.46
	CPUJ	-0.72	-0.59	0.06

Table 5b: Matrix of eigenvectors and values of the principal components for the qualitative characters (Phase II)

Principal components		CP1	CP2
Variance		3.22	1.01
% total contribution		55.54	14.45
% accumulated		55.54	70
Eigenvectors	CLW	-0.39	0.35
	CUL	-0.33	0.54
	CMP	-0.33	-0.46
	CPL	-0.23	-0.57
	CUP	-0.45	-0.19
	CPLJ	-0.44	0.10
	CPUJ	-0.44	-0.01

In Table 4a, the first component (CP1), that describes 43.2% of the variation, is defined by 9 leaf descriptors. The second Component (CP2) that absorbs 17.3% of the variation is represented by 3 descriptors (NLA, NSS and NSR). The third component, with 11.93% of the variation, is defined by 4 parameters (CD, NSS, PH and NBK). Components 4 and 5 (CP4 and CP5) describe each 10.83 and 8.26% of the variation and are characterized by PLID and PH for the component 4, PL and NBK for the component 5.

Clusters based on the morphoquantitative characters of *Cola acuminata* (phase I and II) are presented in Fig. 1. The one of the phase I(A) shows the formation of a great group containing all accessions with the exception of Eseka. This polymorphous group is divided into two subgroups:

- The subgroup I, with 8 accessions of which 7 uniforms and one non uniform (Nkoteng). The subgroup II also distinguishes 8 accessions with 6 uniforms and 2 non uniforms (Mbalmayo and Elig-mfomo).

Cluster of phase I(B) lets also appear a great group composed of 15 accessions, the other (Zoaetele and Bafia), non uniforms, detach himself very extensively of this group. This group is divided into three subgroups:

- Subgroup I contains 7 uniform accessions,
- Subgroup II regrouping Nkoteng and Makenene.

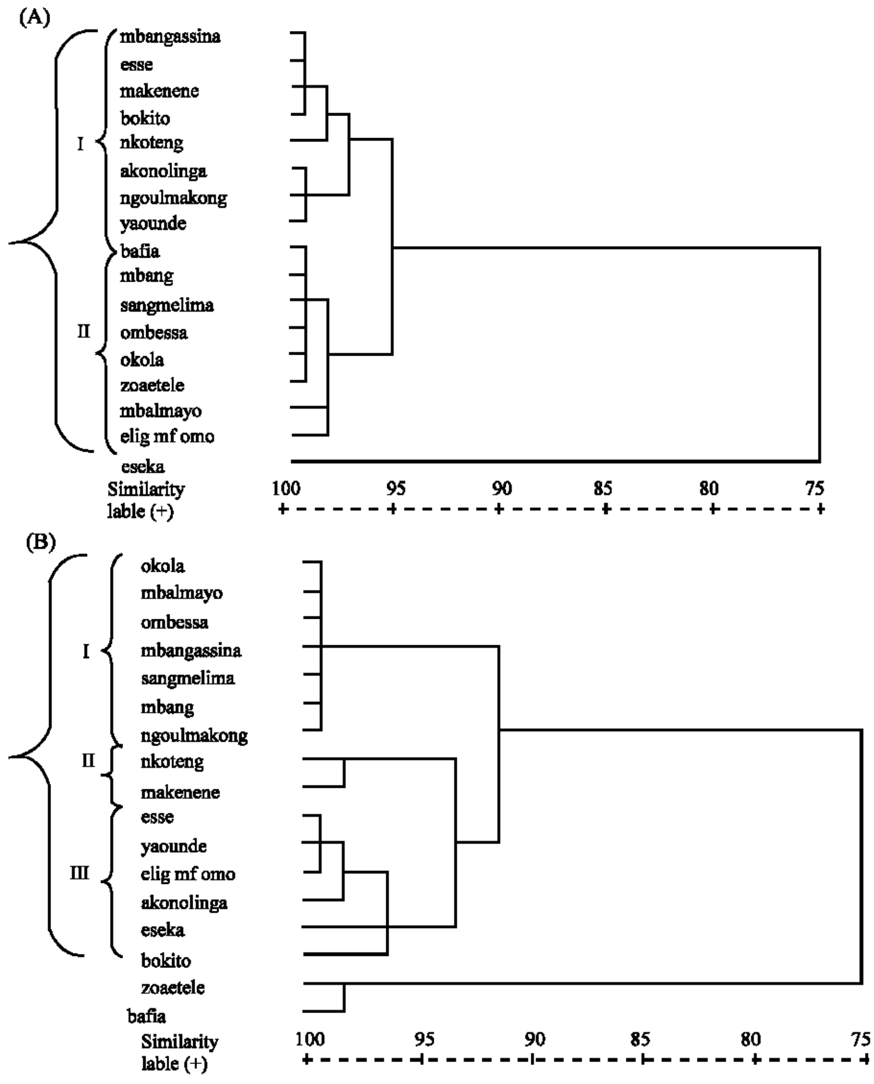

Fig. 1: Dendrogrammes based on morphoquantitatives traits of *Cola acuminata* phase I (A) and phase II (B)

- Subgroup III with 6 accessions, is less steady than the first, with 3 uniforms (Esse, Yaounde and Elig-mfomo) and the other non uniforms,

Clusters of *Cola acuminata* of the phases I and II present the same structure. The growth didn't have an effect on intraspecific variability.

Among accessions composing this species, makenene and nkoteng displayed the better growth whereas mbang and ngoulmakong displayed the weakest growth.

Qualitative traits: All morphoqualitative characters are discriminant for the variability of *Cola acuminata* (Table 5a and b). In the same way, the study of *Colocasia esculenta* (L) Schott germplasm suggested that six leaf and petiole qualitative descriptors contributed in the variability of this plant (Rodriguez *et al.*, 2001). In the morphological characterization and agronomic evaluation of Arracacha (*Arracacia xanthorrhiza*) collection, 26 over 29 qualitative descriptors were polymorphous (Rosso *et al.*, 2002)

The cluster of the 17 accessions of *Cola acuminata* (phase I) based on 7 morphoqualitative descriptors (Fig. 2A) distinguishes this species in four groups when the similarity is 90%:

- Group I contains 9 accessions where 4 are uniforms (Makenene, Mbalmayo, Elig-mfomo and Bokito) and 5 non uniforms.
- Group II is formed by 2 accessions (Nkoteng and Esse) all non uniforms

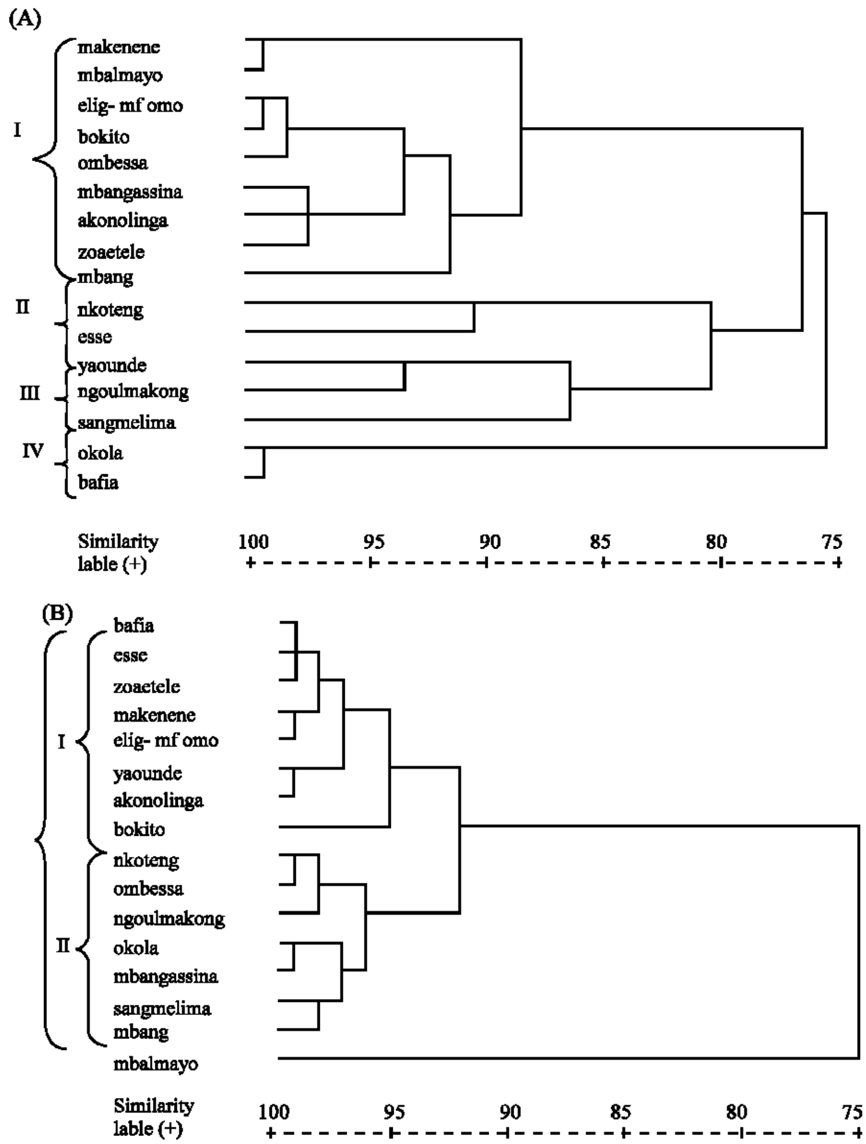

Fig. 2: Dendrogrammes based on morphoqualitatives traits of *Cola acuminata* phase I (A) and phase II (B)

- Group III is composed by Yaounde, Ngoulmakong and Sangmelima.
- The last group contains 2 uniform accessions (Okola and Bafia).

This distribution is independent of the geographical zones characterizing accessions.

The cluster of the second phase of growth presents only one heterogeneous group containing all accessions with the exception of Mbalmayo (Fig. 2B). This group distinguishes two subgroups: the subgroup I composed of 8 accessions where Bokito appears to be the only non uniform, the subgroup II divided in two entities of three to four accessions.

It is noticed that clusters of *Cola acuminata* based on morphoqualitatives traits don't have the same structure: to the phase I, four groups are observed against one to the phase II. This suggests that during the growth, accessions of *Cola acuminata* offer toward a homogeneity.

CONCLUSIONS

All the traits studied have been included in the list of minimum descriptors for the characterization of Cameroonian *Cola acuminata* germplasm. According to these descriptors, accessions can be distinguished in two morphotypes when the two phases of growth are taking into account. Makenene and Nkoteng accessions displayed the better growth whereas Mbang and Ngoulmakong displayed the weakest growth.

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