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Agronomical and morphological diversity of the accessions of cassava in Central African Republic

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Cassava (*Manihot esculenta* Crantz) is an important subsistence food crop in Central African Republic. Data collections for the agronomical and morphological characterization provided 59 accessions of Cassava and were subjected to multivariate analysis to discriminate groups of accessions according to their morphological features. The Eigenvalues of the principal axes extracted from the multivariate analysis indicated that the first two factors explained 7% of the total variability. Generally, morphological variation of the pool of accessions grown in different cassava production sites largely covers the overall variability and therefore there is no structuring in relation to agro-morphological characters from the sites. The dendrogram established on 59 accessions in relation to agronomical and morphological character is divided into two groups. Group A is the smallest with 12 accessions, while Group B has 47. Most of 59 accessions were different on all 44 descriptors. However, some accessions reported under different names, such as "ICRA and six months", "Boots and Assa", were identical on all the characters. In addition, some accessions collected in different places under one name, such as "Six months," have a likeness of all phenotypic traits.

Key words: Agronomical, cassava, diversity, morphological.

INTRODUCTION

Cassava (*Manihot esculenta* Crantz) (*Euphorbiaceae*) is the third largest source of carbohydrates for man in the world and is one of the most important crops in Africa (FAO, 2009). It is efficient in carbohydrate production, adapted to a wide range of environments and tolerant to drought and acidic soils (Fermont et al., 2007).

A sustainable agricultural system requires that components of diversity be used in a way and at a rate that will not lead to a long term decline of diversity, thus maintaining its potential to meet the needs and

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aspirations of present and future generations (Alves, 2002). Genetic diversity is however threatened by the introduction and adoption of modern high yielding varieties (Kosh-Komba, 2013). A dramatic increase in the use of small number of highly selected accessions has led to loss of valuable genetic resources. The proportion of genetic diversity accessed by the popular varieties has often not been determined yet it is critical to the sustainable use of cassava genetic resources in CAR (Duval, 2008). Since cassava is predominantly vegetative propagated, over reliance on a few varieties which may also share a common ancestry may minimize the on farm diversity and thus increase the risks posed by such co-evolving biotic factors as pests and diseases to cassava farming (Fresco, 1986; Fauquet and Fargette, 1990).

Uncoordinated planting and lack of information related to genetic diversity of cassava is one of the factors for low quality cassava starch (Bellon, 1996). Comprehensive study related to various types of cassava in CAR, cultivated or out in the wild was infrequent. This research aims to elucidate the agronomical and morphological diversity of the accessions of cassava in CAR to derive an appropriate breeding strategy.

MATERIALS AND METHODS

Site description

The experimental plot for the agronomical and morphological characterization was located in the village Kapou (Figure 1). Kapou was chosen to represent a range of environments and management practices in cassava-based cropping systems in the mid-altitude zone of CAR. Main soils in the region include ferric and orthic Acrisols and orthic and haplic Ferralsols; soils that are derived from strongly weathered granite or sedimentary parent material (Boulvert, 1986). The climate in all sites is sub-humid with a bimodal rainfall distribution. This allows for the production of most annual crops during both the long (March-August) and the short rains (September-October). Altitude ranges between 1200 and 1500 masl. Cassava is planted in the first 2 months of the short or long rains and remains in the field for about a year. Agricultural systems are diverse with farmers growing 4-6 main crops on average (Conaway et al., 2012). In addition, Kapou is also Experimental Station of PRASAC project where all accessions of cassava in CAR are planted.

Data collection

Data collection for the agronomical and morphological characterization of the accessions was made over a period of twelve months from 45 descriptors of cassava (Fukuda et al., 2010; Emperaire et al., 2003). The data were collected in four steps the third month after planting. First step of characterization had two (2) descriptors (3 months): the color of apical leaves; the pubescence of apical leaves.

Second step of characterization had thirteen (13) descriptors (6 months): leaf retention; the shape of the central leaves, the color of the petiole; the color of leaves; the number of lobes; the lobe length; the lobe width; the lobe of the margin; the length of the petiole; color of the midrib; orientation of the petiole; Flower; pollen. Third step of characterization had nine (9) descriptors (9 months):

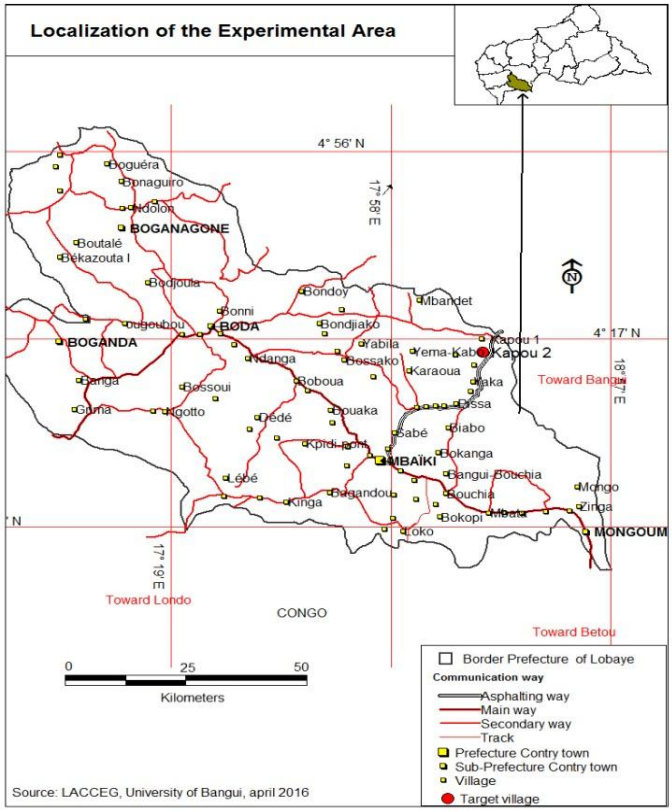

Figure 1. Location of the Kapou in Central African Republic.

leaf scars; the color of the cortex of the shaft; the color of the skin of the stems; color of the outer shaft; the length of the internodes; the shape of the stem; the color of the branches of the adult plant; the length of stipules; margin of states.

Four step of characterization had 20 the descriptors (12 months): fruit; seed; plant height; branch level; plant habit; branching angle; form of the plant; number of tubers/plant; number of marketable tubers; length of root stalk; constriction of the root; form of tubers; external color of the tubers; color of the root pulp; color of the root cortex; cortex: fitness for peeling; texture of the epidermal root; taste roots; average weight of tubers.

Observations on the vegetative were made on a sample of cuttings of 10/20 (10 clones) set collection at each elementary plot. For each accession, cuttings were taken from a sample of three (3) clones to harvest in 12 months to calculate the average number of tubers and the average weight per accession.

Statistical analysis

The data was subjected to multivariate analysis to discriminate groups of accessions according to their morphological features using the software community analysis package Version 2.15 (Henderson and Seaby, 2002).

The factorial analysis of correspondence of morphological descriptors was conducted using the software Cap (Hill, 1979). This analysis project accessions on a plane whose axes are defined as new independent variables composites. Each axis (composite variable) is a combination of morphological descriptors weighted by their level of explanation of the overall variability of the system.

Table 1. Eigenvalues and variance percentage.

	A1	A2	A3	A4
Eigenvalues	0.0587	0.0195	0.0071	0.0048
Variance (%)	0.048	0.021	0.0015	0.0011
Cumulated (%)	0.048	0.042	0.0030	0.1

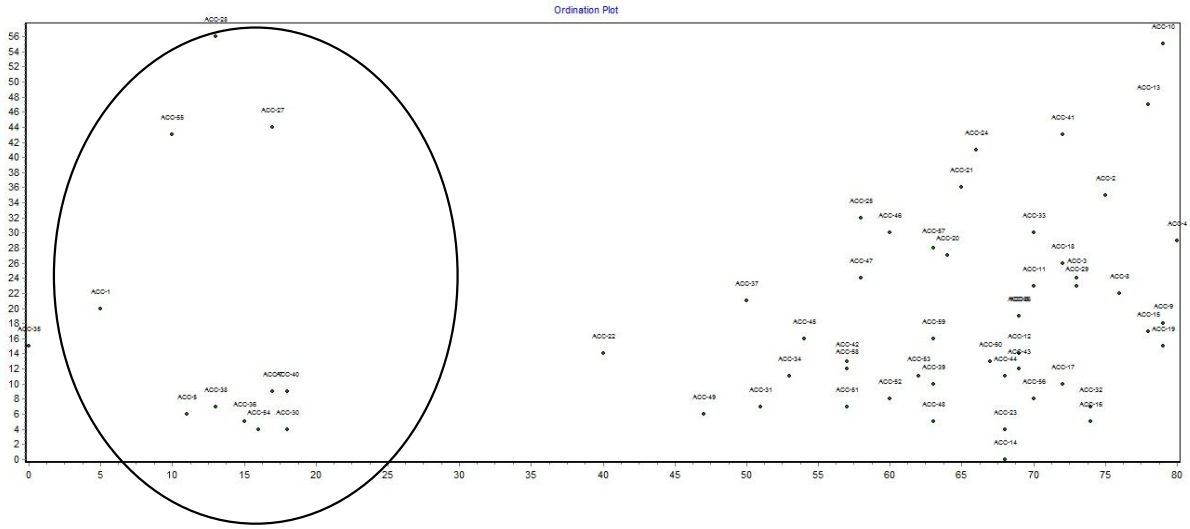

Figure 2. Graphic representation of the 59 accessions from the four axes of the factorial analysis of the correspondences gotten from the 45 morphological describers.

RESULTS

Typology of diversity of cassava

The Eigenvalues (Table 1) of the principal axes extracted from the multivariate analysis indicated that the first two factors explained 7% of the total variability. Generally, morphological variation of the pool of accessions grown in different cassava production sites largely covers the overall variability and therefore there is no structuring in relation to agro-morphological characters from the sites (Figure 2).

Cluster analysis

The dendrogram established on 59 accessions (Table 2) in relation to agro-morphological character is divided into two groups (Figure 3). Group A is the smallest with 12 accessions, while Group B has 47 accessions. Most of 59 accessions were different on all 44 descriptors. However, some accessions reported under different names, such as "ICRA and six months", "Boots and Assa" are identical on all the characters. In addition, some accessions collected in different places under one name, such as "Six months," have a likeness of all phenotypic traits.

Each group is characterized by a number of descriptor. Group A is distinguished by the color of apical leaves (gray and purple); sheets (light green); the length of which is short stipules; of the absence of fruit and seed; port of the plant which is erect and the cylindrical root form. Group B is characterized by the color of the petiole (green) of the main ridge (green). Note the presence of flowers, pollen, fruits and seeds. All other phenotypic traits used in this study have not formed discriminated groups are scattered on all pools.

Cassava variability for root yield traits

Twenty accessions have 7 to 8 root number (Figure 4). There was no correlation between the mean number and the mean weight of roots.

DISCUSSION

The Eigenvalues of the principal axes extracted from the multivariate analysis indicated that the first two factors explained 7% of the total variability. Generally, morphological variation of the pool of accessions grown in different cassava production sites largely covers the

Table 2. Local and gout of accessions.

Groups	Number of accessions	Accessions' local name	Bitter/sweet accessions
A	acc1	ASSA	Bitter
	acc35	B	Sweet
	acc55	Ligbia	Sweet
	acc5	Boumba	Sweet
	acc36	Andjete	Bitter
	acc54	JPN	Bitter
	acc7	Casano Nigeria	Sweet
	acc30	Zaoro-mbissé III	Bitter
	acc38	Babouche	Sweet
	acc40	Bamasson	Bitter
	acc27	Yambolo	Bitter
	acc28	Zaoro-mbissé	Bitter
B	acc2	ASSA	Bitter
	acc15	ICRA	Sweet
	acc9	Claire	Sweet
	acc12	Danzi	Bitter
	acc17	Icra rouge	Sweet
	acc43	Boda	Bitter
	acc14	Giodofondo	Bitter
	acc23	Rendre	Bitter
	acc56	Mondélépacko	Sweet
	acc16	Icra blanc	Sweet
	acc32	Zeteyabongo	Bitter
	acc19	Mboumba	Bitter
	acc39	Babouche	Bitter
	acc44	Cimetière	Bitter
	acc48	Gabon	Bitter
	acc52	Icra	Sweet
	acc50	Gozo-Bangui	Bitter
	acc53	JPN	Bitter
	acc59	Ombella	Bitter
	acc3	Bambari	Bitter
	acc8	Casano Nigeria	Sweet
	acc6	Bozizé	Bitter
	acc11	Claire	Sweet
	acc29	Zaoro-mbissé	Bitter
	acc26	Yaclaire	Bitter
	acc57	Nakowara	Bitter
	acc22	Pipom	Sweet
	acc31	Zaoro-mbissé III	Bitter
	acc49	Gabon	Bitter
	acc45	Cimetière	Bitter
	acc34	Aboundou	Sweet
	acc42	Batamolengué	Bitter
	acc51	Icra	Sweet
	acc58	Ombella	Bitter
	acc4	Bambari II	Bitter
	acc18	Kessembin	Bitter
	acc24	Rendre III	Bitter
	acc10	Claire III	Sweet

Table 2. Contd.

acc13	Garouaboulaye	Bitter
acc20	Mboumba (6 mois)	Sweet
acc25	Séssè	Bitter
acc46	Dongo	Bitter
acc21	Yinfin	Sweet
acc37	Adou	Bitter
acc47	Gabon	Bitter
acc33	Abandou	Sweet
acc41	Bambari	Bitter

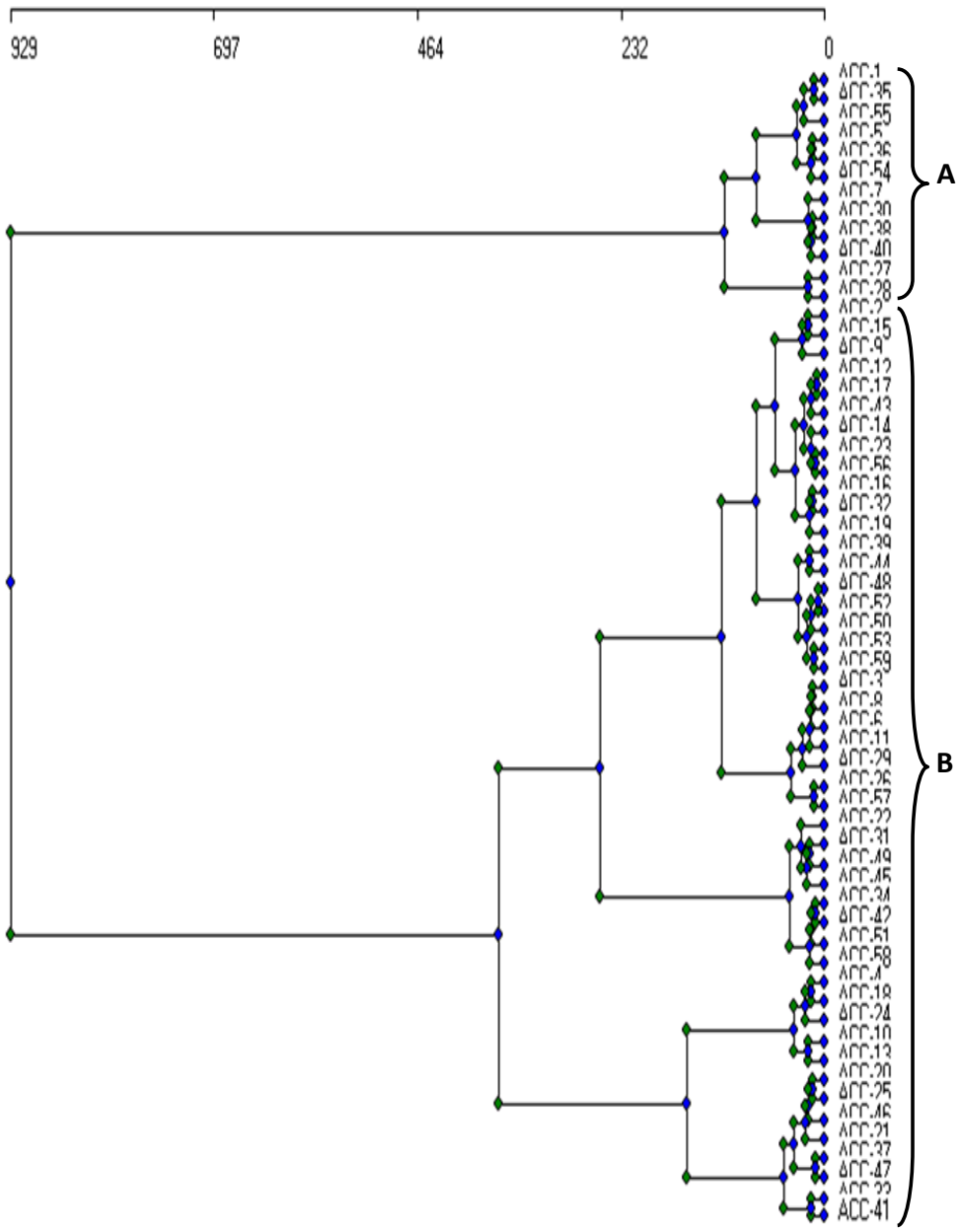

Figure 3. Dendrogram showing hierarchical accessions of 59 cassava phenotypes based on qualitative characters.

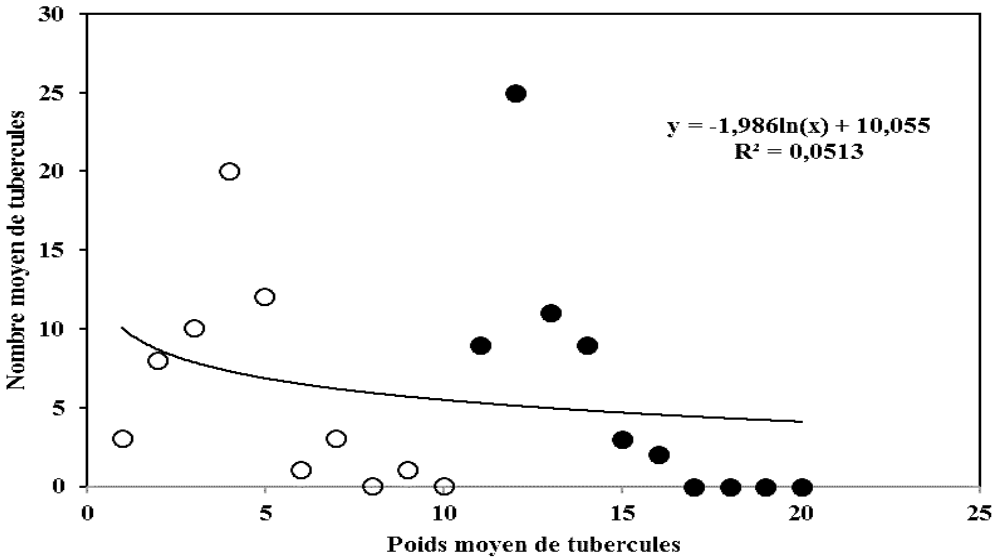

Figure 4. Cassava variability for root yield traits.

overall variability and therefore there is no structuring in relation to agro-morphological characters from the sites.

The dendrogram established on 59 accessions in relation to agronomical and morphological characters is divided into two groups (Figure 3). Group A is the smallest with 12 accessions, while Group B has 47 accessions. The 59 accessions are different on all 44 descriptors. However, some accessions reported under different names, such as "ICRA and six months", "Boots and Assa", are identical on all the characters. In addition, some accessions collected in different places under one name, such as "Six months," have a likeness of all phenotypic traits.

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However, similar study in agronomical and morphological diversity of cassava reported that the total diversity which was given by pubescence on apical leaves, petiole color, color of leaf vein, length of leaf lobe, ratio of lobe length to lobe width of central leaf lobe (Cooper et al., 1992; Alves, 2002).

An agronomical and morphological diversity of cassava is elucidated from pollen and flowers characters, from color of stem cortex, color of stem epidermis and color of stem exterior, from number of leaf lobe, presence of pollen and flowers character (Kosh-Komba, 2013; Asare, 2011).

In Indonesia, an accession 576 of cassava accession from Papua, an agronomical and morphological diversity elucidated that only five characters from nineteen characters give positive effect that is bristle in character, that is, pubescence on apical leaves, petiole color, color of leave vein, length of leaf lobe and ratio between width and length in central leaf lobe (IITA, 2005; Etudaiye, 2009). Based on the result of cluster analysis, cassava accession has diversity length of Euclidian length 1-17. The result of main component analysis shows a relatively high contribution value in 181 cassava accession based on nineteen morphological characters. The result of biplot analysis in 181 accession shows that the deployment of 181 cassava accession is very extensive, there are six groups in two quadrants which are formed relatively far between their groups. It shows that the potential of cassava in Indonesia has an extensive diversity considering the geographical condition of Indonesia that is quite extensive. A geographical effect naturally gives the diversity marker in cassava accession itself (Odoemenem and Otanwa, 2011; Adesehinwa et al., 2011).

An agronomical and morphological diversity of cassava was elucidated for accessions of Manihot low entropy for the descriptors: sinuosity of leaf lobe, flowering, pollen and leaf color developed. It should also be noted that, featuring cassava germplasm found low entropy for the following: stem growth habit, flowering, texture of the epidermis of the root and the root constriction (Nuwamanya et al., 2009; Asare et al., 2011).

Cassava germplasm has larger entropies for the external color of the stem, petiole color, shape and color of the central lobe of the apical leaf descriptors. In the

study of *Manihot* germplasm, the largest entropies were found for petiole color, shape of the central lobe, outside color of stem and number of lobes descriptors (Emperaire et al., 2003; Singh, 1981).

Another work emphasized that the distribution of the variance is associated with the nature and number of characters used in the analysis and focuses on the first principal components used only with a few descriptors of agronomic interest or a group (plant, flowering, fruit and agronomic) (Pereira et al., 1992).

Conclusion

Two distinct grouping were made out of the 59 different cassava accessions based on their similarity level with respect to their agronomical and morphological characters. Group A is the smallest with 12 accessions, while Group B has 47 accessions. Generally, morphological variation of the pool of accessions grown in different cassava production sites largely covers the overall variability and therefore there is no structuring in relation to agro-morphological characters from the sites. The recommendation from this study is that since the study has succeeded in grouping 59 different cassava accessions into two groups, the farmers need to grow only two out of the 59 accessions of cassava, one from each group and have almost all the benefit of rowing all the 59 accessions at a time.

Information on accession diversity, morphology and agronomy, may be used as comprehensive database of local cassava diversity in CAR for further research.

Conflict of Interests

The authors have not declared any conflict of interests.

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