Agronomic Characterization of Bambara groundnuts accessions (*Vigna subterranea* (L.)) on Sudano-Guinean zone, Adamawa-Cameroon

ABSTRACT

Aims: This study aims to identify agronomic traits responsible for the variation between 20 accessions of Bambara groundnuts in order to retain adapted genotype on pedoclimatic conditions of the Sudano-Sahelean area of Cameroon.

Place and Duration of Study: This study was carried out on July 2015 in Dang on Sudano-Guinean zone of Cameroon in order to identify agronomic traits responsible for variation among 20 accessions of Bambara groundnuts.

Methodology: The experimental design in field is a block completely randomized with 3 repetitions. Eleven quantitative characters selected among the describer of Bambara groundnut were evaluated by the multivariate analysis.

Results: The analysis of variance shows a significant difference for ten characters among eleven characters studied which show an important variability between these characters. Seven characters are correlated on two prime of principles components which explaining 44.32 % of total variability. Dendrogram rising of hierarchical classification permit to differentiate 5 groups of morphological diversity. The fifth group gathers the earliest varieties with a time of 121 days maturity. Highly positive correlation is (r=0.72). Characters analyzed may constitute some base of criterion to differentiate the varieties from others regions and must be used on the program of improvement varieties of Bambara groundnut in Cameroon.

Conclusion: In all of the 11 characters evaluated in this study, only one of them could not differentiate the accessions. Important variability between characters was observed. The rising of hierarchical classification showed one of important agronomic diversity and regroup the accessions in 5 groups.

Keywords: Bambara groundnut, Analysis of principles components, rising of hierarchical classification, correlation.

1. INTRODUCTION

Bambara groundnut (*Voandzeia subterannea* (L.)) is the third food leguminous most important in terms of production and consummation in Africa, after peanut (*Arachis hypogeae* (L.)) and Cowpea (*Vigna unguiculata* (L.)) (Linnemann, 1992; Howell, 1994). Their seeds are rich in calories, mineral elements, vitamin and proteins (Amarteifio *et al.,* 2006; Ndiang *et al.,* 2012). It has therapeutic property and hence is popular among the rural populations (Nacoulma, 1996). Bambara groundnut have positive impact on soil fertility due

to their ability to fix atmospheric nitrogen and enhance yield of plants around 350 to 800 kg/ha in region where soil is poor and rainfall is relatively low (Bonny and Djè, 2011; Touré *et al.,* 2013). This stability of production could be due to their adaptation traits on tropical climate and genetic diversity of seeds sowed (Azam-Ali *et al.,* 2001). Some morphotypes resist well on insect attacks, diseases and on critical conditions of dryness (Mungate, 1997; Touré *et al.,* 2013). According to their importance, Bambara groundnut is considered like minor culture and not used in varietal selection program (Zerihun, 2009). However these cultures have several potentialities for genetic amelioration according to their diversity founded on many accessions collected from country (Basu *et al.,* 2004; Ntundu *et al.,* 2004; Djè *et al.,* 2005; Bonny et Djè, 2011).

In Sudano-sahelean area, the production of seeds is relatively low due to poor soil fertility (Minader, 2012). However, from an agronomic context, the knowledge of genetical mechanisms could help to develop strategies of selection in order to retain high genotype adapted on pedo-climatic conditions of Sudano-sahelean zone. Many accessions of Bambara groundnut collected on different area of Cameroon have different characters (Pasquet et Fotso, 1991; Ndiang *et al.,* 2012; Sobda *et al.,* 2013). Research or new knowledge on variety on high yield of Bambara groundnut is a principal objective of selection. General objective of this research is to identify agronomic traits responsible for the variation between 20 accessions of Bambara groundnuts in order to retain adapted genotype on pedoclimatic conditions of the Sudano-Sahelean area of Cameroon.

I- MATERIALS AND METHODS

I.1. DESCRIPTION OF STUDY

Dominant trait of this area (Sudano-Sudano-sahelean climate type) of Cameroon is a massif of Adamawa with a mountainous arch which separate northern and southern part of country. Adamawa plateau is dominated with a plain of Bénoué in the north and in west with Nigeria. This region extends to south-west by the high volcanic mountain with altitude of 2460 m (Rippstein, 1985).

I.2. EXPERIMENTAL SITE

The study was conducted in Dang located at 700 m of Campus University of Ngaoundere at Bini-Dang. The village is situated at 15 kilometers of the town of Ngaoundere (1113 m of altitude with latitude of 7.28° North and longitude of 13.34° East). Climatic conditions of this site are characteristic of Sudano-guinnean zone. Geographic localization of this experimental site is 13°34'238" East and 7°24'671" North with altitude of 1155.8 m.

I.3 VEGETAL MATERIALS

Biological material is constituted of 20 morphotypes of Bambara groundnuts (*Vigna subterranea*) obtained from laboratory team of Biodiversity of University of Ngaoundere (**Figure 1**)

Figure 1: Accessions of Bambara groundnut.

I.4 EXPERIMENTAL DESIGN

The experimental design for this study is a block completely randomized with 3 replications. Ridge distances are respectively 1m, with 0.5m of length and width. The total surface of ridge is 0.5 m^2. A total of 60 ridges were materialized with total experimental plot size of 61.95 m² (4.2 m x 14.75 m). Distance among ridge is of 60 cm and 25 cm. Seeds were sowed in the soil at 3 cm of depth with a space of 20 cm between pockets. For each of the 20 morphotypes, twelve seeds were sowed on each ridge. Each morphotype is represented by 36 plants. Sowing process was done on July 2015 at Bini-Dang. Data collection was made according to the list of describer of Bambara groundnut (IPGRI/IITA/BAMNET, 2000).

I.5. EVALUATION OF AGRONOMIC PARAMÈTERS

Eleven parameters were chosen within the describers of Bambara groundnut to characterize and evaluate different morphotypes (Table 1). All the measurements were done on 5 plants of each morphotype.

Table 1: Parameters used to characterize the morphotypes.

N°	**Parameters**	**Methods**
1	Germination rate (%)	Determined with formula
2	Date of first flowering (DAS)	Count at the day after sowing
3	Date of 50 % flowering (DAS)	Count at the day after sowing
4	Height of plants (cm)	Measuring with a ruler
5	Number of leaves per plant	Count during vegetative growth
6	Number of stems per plant	Count during vegetative growth
7	Number of pods per plant	Determine after harvest by counting
8	Number of seeds per pod	Count seeds after drying
9	Weight of 100 seeds (g)	Weighing 100 seeds with electronic balance
10	Yields of seeds per plant (g)	Weighing of seeds with electronic balance
11	Life cycle (DAS)	Count day since sowing to harvest

$$\boldsymbol{Germination\ rate} = \frac{\textbf{Number of seeds germinated}}{\textbf{number of seed on the try}} \times \mathbf{100}$$

Total numbers of pocket = number of germinated pocket + number of empty pocket.

I.6. STATISTICAL ANALYSIS

For the different characters studied, a comparison of means within morphotypes by ANOVA test with software STATGRAPHICS PLUS Version was done. For a highest significant difference between morphotypes for one character given, ANOVA is completed by the test of small significant difference (ppds). Which permit to identify the different morphotypes that significantly differed from others (Dagnelie, 1998). Different performances of morphotypes for each quantitative character were evaluated on determining the minimum, maximum, average, standard-error and variation index. Evaluation of morphological diversity structuration was done by a Principal Component Analysis (ACP), a rising of hierarchical Classification (CAH) in order to appreciate the degree of similarity between analyzed unities and understand the phylogenetic relationship existing between them with the software XLSTAT Version 2007.8.04. Correlation coefficient of Bravais Pearson was used to test and appreciate the degree of association between the different characters studied.

II. RESULTS AND DISCUSSION

II.1 VARIABILITY ANALYSIS OF AGRONOMIC PARAMETERS

Table 2a and 2b presents the variability of different morphotypes for the eleven agronomic parameters. ANOVA revealed a significant difference ($p<0.05$) between variety : germination rate, date of first flowering, date of 50 % of flowering, height of plants, number of stems per plant, number of pods per plant, number of seeds per pods, weight of 100 seeds, yields of seeds per plant and maturation time. However, there was no significant difference in the number of leaves per plant.

Table 2a: Genetic variability of 20 morphotypes for the 11 agronomic parameters.

Variety	TG (%)	DFl (JAS)	DF50%l (JAS)	HaP (cm)	NFe	NTg
CM/EN/AE/O2	63,88±33,67^{defgh}	50,33±0,57^{cdefg}	65,33±2,51^{bcde}	22±1,8^{ab}	95±8,52	6,33±0,76^{bcde}
CM/EN/DW/03	27,77±4,8^{ab}	46±2,00^{abcd}	62,33±1,52^{bcd}	22,68±3,48^{ab}	141,33±67,66	7,33±1,44^{ef}
CM/AD/MC/04	19,44±4,81^{a}	52±6,08^{fg}	62,33±2,08^{bcd}	22,56±1,25^{ab}	138,5±57,82	6,16±0,76^{abcde}
CM/AD/MC/05	33,33±14,43^{abc}	45,66±3,78^{abc}	62,33±1,52^{bcd}	24,25±4,02^{ab}	197,5±21,54	6,33±0,76^{bcde}
CM/EN/DW/07	69,44±39,38^{efgh}	45,33±2,51^{ab}	62,33±1,15^{bcd}	23,1±0,4^{ab}	115,5±10,81	4,83±0,28^{ab}
CM/EN/DW/09	47,22±4,8^{abcdef}	53±1,00^{g}	65,33±2,08^{bcde}	21,78±2,33^{ab}	118±43,53	4,66±0,76^{a}
CM/EN/AE/10	75±8,33^{fgh}	43±0,00^{a}	61±0,00^{bc}	24,58±3,64^{abc}	151,5±13,74	6±1,32^{abcde}
CM/EN/AE/13	66,66±22,04^{efgh}	48,33±3,51^{bcdefg}	64,66±3,51^{bcde}	21,58±2,96^{ab}	162,5±23,82	5,6±60,28^{abcd}
CM/EN/DW/14	75±8,33^{fgh}	49,33±2,30^{bcdefg}	66,66±5,77^{de}	23,33±2,02^{ab}	158,5±83,37	6±0,86^{abcde}
CM/AD/AE/15	77,77±12,73^{gh}	50,66±1,15^{defg}	54,33±8,08^{a}	30,13±2,87^{d}	191±45,92	6,66±1,75^{cdef}
CM/AD/MC/16	66,66±36,32^{efgh}	52,66±1,52^{fg}	62,33±1,52^{bcd}	32,91±6,87^{d}	138,5±36,13	5,16±1,04^{abc}
CM/AD/MC/17	72,22±9,61^{fgh}	51,66±1,52^{efg}	62,66±1,52^{bcd}	33,66±1,75^{d}	143,5±42,64	5,66±1,15^{abcd}
CM/AD/MC/18	75±8,33^{fgh}	48±0,00^{bcdef}	60±0,00^{b}	29,16±1,66^{cd}	171,5±64,73	6,66±0,76^{cdef}
CM/EN/DW/19	41,66±16,66^{abcde}	51,66±3,51^{efg}	68,66±1,52^{e}	20±2,94^{a}	150±68,73	5,33±0,76^{abc}
CM/EN/DW/20	55,55±4,8^{bcdefg}	47,33±4,04^{abcde}	64,33±5,13^{bcde}	23,08±2,09^{ab}	186,5±36,81	7±0,86^{def}
CM/EN/DW/21	80,55±12,72^{gh}	50,33±2,08^{cdefg}	66,33±2,51^{cde}	22,01±1,76^{ab}	161±50,58	6±1,00^{abcde}
CM/EN/DW/23	58,33±8,33^{cdefg}	50,66±5,13^{defg}	62,66±4,61^{bcd}	21,58±2,4^{ab}	132±37,58	8±0,86^{f}
CM/EN/DW/27	36,11±4,81^{abcd}	53±2,264^{g}	62,66±2,51^{bcd}	22,93±2,72^{ab}	202±42,46	7±0,86^{def}
CM/EN/DW/28	61,11±9,62^{cdefgh}	45,66±3,05^{abc}	62,66±3,51^{bcd}	25,05±2,22^{bc}	140±29,63	6,66±1,6^{cdef}
CM/EN/DW/29	88,89±4,81^{h}	48,66±3,51^{bcdefg}	62,66±2,51^{bcd}	23,48±1,34^{ab}	143±19,34	5,66±0,76^{abcd}
Moyenne	**59,58±23,66**	**49,16±3,76**	**63,08±3,79**	**24,49±4,45**	**151,86±41,18**	**6,15±1,16**
PPDS (5%)	**30,55**	**5**	**6**	**5,03**		**1,66**

NB: On the same lines, means following by the same letter are not significantly different at the level of probability considered ($P \leq 0.05$).
TG=germination rate; **DFl**=date of first flowering; **DF50%l**=date of 50% flowering; **HaP**=height of plant; **NFe**=number of leaves; **NTg**= number of stems.

Table 2b: Genetic variability of 20 accessions for the 11 agronomic parameters.

Accessions	NGs	NGr	P100gr (g)	RGr (g)	TEm (JAS)
CM/EN/AE/O2	15,83±5,00^{abc}	1,19±0,17^{a}	78,46±2,07^{gh}	15,7±4,85^{abc}	123,33±2,88^{cde}
CM/EN/DW/03	25,16±4,85^{ef}	1,22±0,38^{a}	68,53±5,18^{def}	22,33±3,01^{bcde}	125±0,00^{def}
CM/AD/MC/04	14,66±8,60^{a}	1,11±0,19^{a}	105,7±0,00^{j}	18,06±9,12^{abcd}	125±0,00^{def}
CM/AD/MC/05	21±4^{abcde}	1,08±0,14^{a}	76,23±7,67^{fgh}	20,46±4,81^{bcde}	123,33±2,88^{cde}
CM/EN/DW/07	14,33±1,52^{a}	1,80±0,17^{bcde}	93,46±7,82^{i}	20,13±3,03^{bcde}	126,66±2,88^{ef}
CM/EN/DW/09	19±7,21^{abcde}	1,44±0,38^{abc}	55±12,12^{ab}	14,46±3,99^{ab}	125±0,00^{def}
CM/EN/AE/10	17±6,08^{abcd}	1,00±0,00^{a}	60,6±6,00^{abcd}	10,76±4,29^{a}	118,33±5,77^{ab}
CM/EN/AE/13	23,66±1,15^{cdef}	1,5±0,17^{abc}	55,36±3,70^{ab}	19,6±1,25^{bcde}	128,33±2,88^{f}
CM/EN/DW/14	19±3,12^{abcde}	1,5±0,17^{abc}	51,46±4,04^{a}	18,1±2,26^{abcd}	123,33±2,88^{cde}
CM/AD/AE/15	15,5±4,92^{ab}	1,89±0,19^{cde}	54,13±3,53^{ab}	18,93±7,44^{bcde}	121,66±2,88^{bcd}
CM/AD/MC/16	14,83±2,02^{a}	2,33±0,33^{e}	60±4,47^{abcd}	21,16±1,94^{bcde}	125±0,00^{def}
CM/AD/MC/17	16,66±5,75^{abcd}	2,22±0,69^{de}	52,76±5,10^{a}	16,13±9,13^{abc}	123,33±2,88^{cde}
CM/AD/MC/18	16,33±2,92^{abcd}	1,77±0,38^{bcd}	62,66±2,05^{bcde}	16,4±6,2^{abc}	120±0,00^{bc}
CM/EN/DW/19	24,16±6,00^{def}	1,77±0,38^{bcd}	54,76±2,21^{ab}	22,76±5,44^{cde}	126,66±2,88^{ef}
CM/EN/DW/20	15,66±1,52^{ab}	1,5±0,17^{abc}	67,3±7,06^{cdef}	15,4±0,95^{abc}	120±5,00^{bc}
CM/EN/DW/21	13,83±2,92^{a}	1,30±0,33^{ab}	66,5±9,10^{cde}	14,53±3,8^{ab}	120±5,00^{bc}
CM/EN/DW/23	14±4,27^{a}	1,41±0,52^{abc}	83,6±2,00^{h}	16,43±4,62^{abc}	125±0,00^{def}
CM/EN/DW/27	30,83±5,00^{f}	1,5±0,17^{abc}	61,06±2,55^{abcd}	26,76±3,06^{e}	125±0,00^{def}
CM/EN/DW/28	23,33±5,00^{bcdef}	1,4±0,41^{abc}	58,73±9,20^{abc}	23,26±1,95^{cde}	115±0,00^{a}
CM/EN/DW/29	19,83±5,34^{abcde}	1,41±0,22^{abc}	70,86±4,75^{efg}	25,36±4,21^{de}	120±5,00^{bc}
Moyenne	**18,73±6,01**	**1,52±0,43**	**66.86±14,98**	**18,84±5,61**	**123±4,03**
PPDS (5%)	**8**	**0,55**	**9,8**	**8,23**	**5**

NB: On the same lines, means following by the same letter are not significantly different at the level of probability considered ($P \leq 0.05$).
NGs=Number of pods per plant; **NGr**=Number of seeds per plant; **P100gr**=Weight of 100 seeds; **RGr**=Yields of seeds per plant; **TEm**=Maturation time.

II.2 VARIABILITY OF QUANTITATIVE PARAMETERS OF AGRONOMIC DIVERSITY

Results from **Table 3** indicate important standard between the minimum and maximum. Variation index were between 2.66 % (time of maturation) from 32.38 % (germination rate). High values (CV>20 %) was observed for 5 of 11 characters analyzed. All of results traduce the existence of important diversity within the species. This important phenotypic variability observed could result from the expression of high genotypic heterogeneity but also of the influence of some environmental factors. These different accessions have a germination rate that varies from 19.44 to 88.89 %

These results corroborate to works of results of Touré et al. (2013) in Côte d'Ivoire, were reported that germination rate on Bambara groundnut varies from 26.8 to 91.25 %. Contrary, these results did not corroborate to works of Djé et al. (2005) who found that germination rate varies from 64 to 88 % on fourth morphotypes. Variability response expressed within our conditions may traduce heterogeneity of germinative quality of seeds that arising principally from state purity of seeds and their physiology.

Contrary to this observation, Massawe et al. (2002) showed a favor effect of height of seeds on appearance of plants. These different accessions of Bambara groundnut have a flowering at 50 % that varies from 54 to 89 days. These results are not similar to works obtained by Brink et al. (2006) and Amadou et al. (2015), who reported respectively a period of 32 to 42 days and 33 to 40 days respectively. These different results could be explained by the difference in number of variety studied in our study and geographical provenances are unknown. Dimakatso (2006) reported that flowering on Bambara groundnut is undetermined. The date of flowering could be recorded like good trait agronomic in the program of amelioration of Bambara groundnut in Cameroon. Accessions of Bambara groundnut tested have a height of around 20 and 33.66 cm with 5 to 8 stems.

Theses observations corroborate to the works obtained by Ndiang et al. (2012) in Cameroon, which showed that the height of plants varies from 20 to 38 cm with 5 to 8 stems. Contrary, these values are different from those obtained by Sobda et al. (2013) in Cameroon who reported that the number of stems per plant varies between 16 and 24. Number of pods per plants in this study varies between 14 and 31 respectively. Theses results are different from the findings of Ouédraogo et al. (2008) in Burkina Faso on 310 accessions and prove that the number of pods on Bambara groundnut varied from 4 to 50. The difference observed within our experiment could be explained by the difference between morphotypes, state of fertility of experimental plots and local climatic conditions. Weight of 100 seeds varies from 51.46 to 105.7g. These results corroborate with the works obtained by Bonny et Djè (2011) in Côte d'ivoire, who reported that weight of 100 seeds on Bambara groundnut varied between 35.83 and 111.3g. Results are in contradiction to the works of Ndiang et al. (2012) in Cameroun and Touré et al. (2012) in Côte d'ivoire that found total weight of 100 seeds were in range of 52 to 82g and 40.71 to 76.54g respectively.

These differences obtained could be explained by the cultivation of accessions on a humid border on different climatic and ecologic conditions of the production area (on a high humidity of soil due to rain). Yield of seeds per plant in this study fluctuate from 10.76 to 26.76g. These results corroborate with result obtained by Shegro et al. (2013) in South Africa, who reported that yield of seeds per plant on Bambara groundnut varied between

10.20g and 57g. Amplitude time for maturation varies from 115 to 128 days. Results correspond to works of Goli et al. (1997) in Burkina Faso that reported the duration of life cycle of Bambara groundnut varied between 100 and 160 DAS. However, results differed from those obtained by par Ndiang et al. (2014) in Cameroon. These scientists reported that the duration of life cycle on Bambara groundnut is 90 days. In fact, numerous previous works showed that the length of day (Harris & Azam-ali, 1993; Linnemann *et al.,* 1995; Brink, 1999), temperature (Linnemann & Craufurd, 1994; Brink, 1998) and humidity (Collinson *et al.,* 1996) cause variable effects on vegetative and physiological development of Bambara groundnut.

Table 3: Performances of 11 quantitative characters measured for 20 accessions.

Variables	Observations	Minima	Maxima	Means	Standard error	CV (%)
TG (%)	20	19.44	88.89	59.58	19.30	32.38
DF1 (JAS)	20	43.00	53.00	49.16	2.92	5.94
DF50%1 (JAS)	20	54.33	68.66	63.08	2.93	4.64
Hap (cm)	20	20.00	33.66	24.49	3.85	15.72
Nfe	20	95.00	202.00	151.87	27.92	18.34
NTg	20	4.66	8.00	6.15	0.84	13.66
NGs	20	13.83	30.83	18.73	4.63	24.72
NGr	20	1.00	2.33	1.52	0.35	23.03
P100gr (g)	20	51.46	105.70	66.86	14.43	21.58
RGr (g)	20	10.76	26.76	18.84	4.02	21.33
TEm (JAS)	20	115.00	128.33	122.99	3.27	2.66

TG=germination rate; **DF1**=date of first flowering; **DF50%1**=date of 50% of flowering; **HaP**=height of plants; **Nfe**=number of leaves per plant; **NTg**=number of stems per plant; **NGs**=number of pods per plant; **NGr**=number of seeds per pods; **P100gr**=weight of 100 seeds; **RGr**= yield of seeds per plant; **TEm**=maturation time.

II.3. STRUCTURATION OF AGRO-MORPHOLOGIC DIVERSITY BY PRINCIPAL COMPONENT ANALYSIS (ACP)

Table 4 shows proper values and contribution of characters on the axis of analysis of principal component (ACP). ACP indicates that the fourth primary component explains respectively 23.53 %; 19.79%; 19.13 % and 12.15 % of the variability, with around 75.6 % of the total variability. The two primary components which recorded 44.31% of the variance were retained for analyzing the agronomic variability of accessions. **Axis 1** that explains 24.53 % of variability showed the highest correlation with height of plants, germination rate and yield of seeds per plant. **Axis 2** with 19.79 % of variance defines the phenology and yield parameters. The date of first flowering, the date of 50 % flowering, maturation time, number of pods per plant, number of seeds per pod and yield of seeds per plant are positively correlated in this axis. These characters that are positively correlated on two axes are factors most discriminant suggesting their consideration in the selection for the important agronomic traits.

Table 4: Proper values and contribution of characters on axis of component of principal analysis.

	Axe 1	Axe 2	Axe 3	Axe 4
Valeur propre	2,698	2,176	2,104	1,337
Variabilité (%)	24,528	19,786	19,129	12,150
% cumulé	24,528	44,314	63,443	75,593
caractères définissant les axes et leurs valeurs propres				
TG	0,740	-0,169	-0,114	-0,405
DFl	0,029	0,630	-0,326	0,283
DF50%l	-0,505	0,203	-0,477	-0,541
Hap	0,854	0,212	0,151	0,279
Nfe	0,070	0,154	0,778	0,022
NTg	-0,194	-0,345	0,622	0,314
NGs	-0,520	0,516	0,542	-0,295
NGr	0,667	0,632	-0,133	0,154
P100gr	-0,408	-0,458	-0,300	0,621
RGr	-0,306	0,594	0,406	0,108
Tem	-0,385	0,542	-0,421	0,339

TG=taux de germination ; DFl=date de 1ère floraison ; DF50%l=date de 50% de floraison ; HaP=hauteur des plantes ; Nfe=nombre des feuilles par plante ; NTg=nombre des tiges par plante ; NGs=nombre de gousses par plante ; NGr=nombre des graines par gousse ; P100gr=poids de 100 graines ; RGr=rendement en graine par plante ; TEm=temps de maturation.

II.4. DIVERSITY ANALYSIS OF ACCESSIONS RISING OF HIERARCHICAL CLASSIFICATION (CAH)

Dendrogram rising to hierarchical classification (Figure 2) revealed a repartition of 20 accessions in 5 groups. The groups 1 is constituted of 3 accessions (CM/EN/AE/02, CM/EN/DW/07, CM/EN/DW/23). The groups 2 that constituted 3 accessions (CM/EN/DW/03, CM/EN/DW/09, CM/EN/DW/19), characterized by a cycle of maturation of 126 days. Variety (CM/AD/MC/04) constitute the group 3 with, with a weight of 100 seeds most high (105.7g). This variety could be selected for a food security. The group 4 includes 3 accessions (CM/AD//04, CM/EN/DW/20, CM/EN/DW/27). This group is characterized by a yield of seeds per plant most high (20.7g). The group 5 is composed of 10 accessions (CM/EN/AE/10, CM/EN/AE/13, CM/EN/DW/14, CM/AD/AE/15, CM/AD/MC/16, CM/AD/MC/17, CM/AD/MC/18, CM/EN/DW/21, CM/EN/DW/28, CM/EN/DW/29.

It is characterized by a germination rate most high (73.88 %), a flowering between 48 and 62 days, with a height of 26.56 cm. this group is constituted of morphotype with earlier cycle. The precocity of cycle of these accessions made this culture interesting for rural farmers during the weld period, because they achieve their maturity before others variety and constitute one important source of income for producers and reseller. Morphological and

phenological difference observed between different groups of phenotypic diversity suggested that accessions are maintained under evaluative processes which are different to their agro-ecosystem respectively. Agro-ecosystems are susceptible to exert variable selective pressure on genotypes (Doku & Karikari, 1971; Sadiki & Jarvis, 2005).

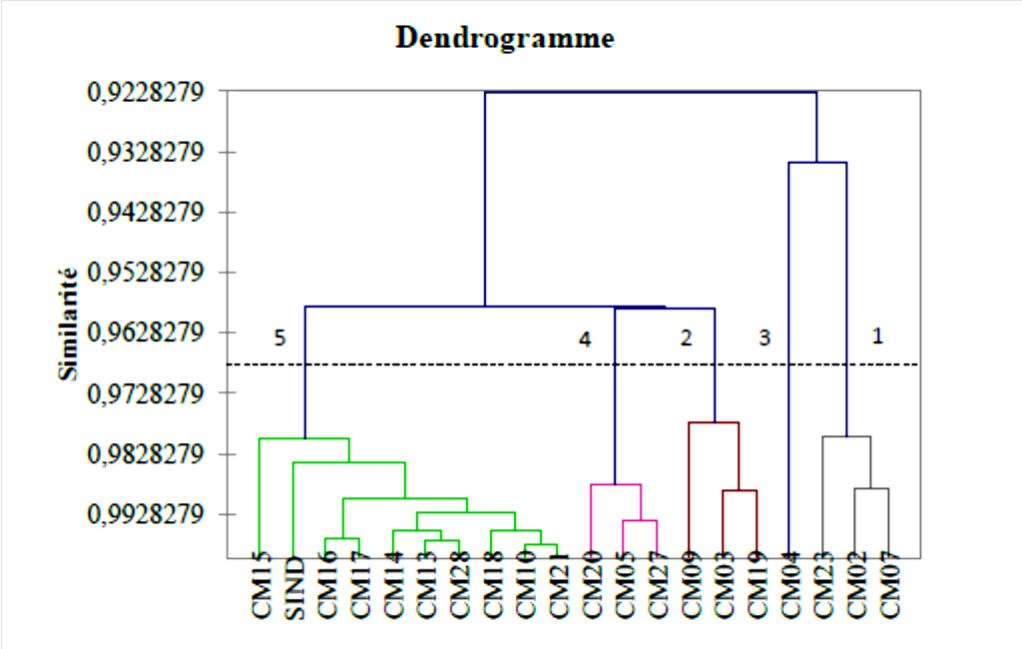

Figure 2: Dendrogram rising to hierarchical classification of accessions of Bambara groundnut.

Average performance of characters of different groups formed rising to hierarchical classification are represented on **Table 5.**

Table 5: Means performances of characters of different groups obtained by CAH.

Groupes	TG	DFl	DF50%l	Hap	Nfe	NTg	NGs	NGr	P100gr	RGr	TEm
1	63.87	48.77	63.44	22.22	114.16	6.38	14.72	1.46	85.17	17.42	124.99
2	38.88	50.22	65.44	21.48	136.44	5.77	22.77	1.47	59.43	19.85	125.5
3	19.44	52.00	62.33	22.56	138.50	6.16	14.66	1.11	105.70	18.06	125.00
4	41.66	48.66	63.10	23.42	195.33	6.77	22.4	1.36	68.19	20.87	122.77
5	73.88	48.82	62.32	26.58	156.10	6.01	17.99	1.63	59.30	18.42	121.49

TG=germination rate; **DF1**=date of first flowering; **DF50%1**=date of 50% of flowering; **HaP**=height of plants; **Nfe**=number of leaves per plant; **NTg**=number of stems per plant;

NGs=number of pods per plant; **NGr**=number of seeds per pods; **P100gr**=weight of 100 seeds; **RGr**= yield of seeds per plant; **TEm**=maturation time.

II.5 CORRELATIONS BETWEEN PARAMETERS STUDIED

Table 6 shows the correlation among the 11 characters that presented the variability. High positive correlation r=0.72 was observed between the height of plant and number of seeds per plant. A correlation r=0.67 bind the number of pods per plant and the yields of seeds per plant. The high negative correlation (r=-0.58) was considerate between the height of plants and the date of 50 % flowering. The positive correlation observed between characters could facilitate the genetic amelioration of all others characters correlated positively. Contrarily, negative correlation observed between the characters studied could limit the selection, possibility to obtain cultivar with earlier cycle and a high yield producing heavy seeds that producers and consumers needed. Correlations constitute an important tool for amelioration of characters on integrating on a program of selection.

Table 6: Correlation Matrix of Pearson of 11 agronomic parameters.

Variables	TG	DFl	DF50%l	Hap	Nfe	NTg	NGs	NGr	P100g	RGr	TEm
TG	**1**										
DFl	-0,149	**1**									
DF50%l	-0,162	0,189	**1**								
Hap	0,361	0,126	**-0,576***	**1**							
Nfe	-0,085	-0,069	-0,311	0,157	**1**						
NTg	-0,221	-0,155	-0,303	-0,095	0,355	**1**					
NGs	-0,426	-0,013	0,197	-0,293	0,338	0,130	**1**				
NGr	0,344	0,406	-0,173	**0,712****	0,011	-0,328	-0,151	**1**			
P100g	-0,361	-0,115	-0,067	-0,318	-0,321	0,142	-0,370	-0,391	**1**		
RGr	-0,261	0,126	-0,013	-0,058	0,211	0,051	**0,674***	0,187	-0,017	**1**	
Tem	-0,406	0,425	0,263	-0,218	-0,166	-0,266	0,156	0,191	0,185	0,188	**1**

NB:*significatif (5%); **très significatif (1%); **TG**=germination rate; **DF1**=date of first flowering; **DF50%1**=date of 50% of flowering; **HaP**=height of plants; **Nfe**=number of leaves per plant; **NTg**=number of stems per plant; **NGs**=number of pods per plant; **NGr**=number of seeds per pods; **P100gr**=weight of 100 seeds; **RGr**= yield of seeds per plant; **TEm**=maturation time.

CONCLUSION

In all of 11 characters evaluated in this study, only one of them did not differentiate the accessions. Important variability between these characters was observed. Rising of hierarchical classification showed an of important agronomic diversity and regroup the accessions in 5 groups. Agro-morphological diversity observed in this study revealed that these accessions constitute a good reservoir for the genetical characteristic of Bambara groundnut. Correlation observed among morphologic and agronomic parameters made the characters concerned as important index to use in the program of amelioration. The characters analyzed could constitute basic criteria to differentiate variety in others regions and could be used in the program of varietal amelioration of Bambara groundnut in Cameroon.

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