

1                   **Phenological, morphological and agronomic**  
2                   **characterization of Bambara groundnut genotypes on**  
3                   **plinthite soil in East-centre area, Burkina Faso**  
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16                   **ABSTRACT**

17                   Bambara groundnut has long been a neglected and understudied crop. Thanks to the new orientations for  
18                   the développement of agriculture and achievement of food security in Burkina Faso, in recent years, studies  
19                   on Bambara groundnut have experienced renewed interest. Despites nutritional, agronomic and socio-  
20                   economic importance and some studies carried out on this crop. The diversity within Bambara groundnut  
21                   cultivated remains poorly understood. The objective of this study was to assess phenological morphological  
22                   and agronomic characterization of 20 Bambara groundnut accessions from National Institute for the  
23                   Environment and Agricultural Research (INERA) genebank. The experimental device used was a completely  
24                   randomized Fisher blocks with four replications on the site of University Centre of Tenkodogo. These  
25                   accessions were evaluated on 23 morphological characters including four qualitative characters and 19  
26                   quantitative characters. Qualitative traits showed high proportion of oval terminal leaflet shape (70%), cream  
27                   coloured seeds (45%) and 80% presence of eyes of various shapes and colours. The analysis of quantitative  
28                   characters showed all the characters are discriminating except the plant spread (PIS) at the 5% treshold with  
29                   regard to morphological, physiological and agronomic traits and low coefficient of variation (CV) values for  
30                   the different phenological characters, except for the number of days from sowing to 50% plantlet emergence  
31                   (EMG50). Pearson correlation matrix indicated positive and negative correlation. Most of the negative

32 correlation was observed between phenological and agronomic traits The dendrogram showed organization  
33 of the variability in three different groups on the basis of the physiological, phenological and agronomic traits.  
34 The variability expressed among INERA gene bank genotypes showed important variability, which can be  
35 exploited in Bambara groundnut breeding programs using the clustering and associations of characters.

36 **Key words:** Bambara nut, Burkina Faso, characterization, morphological, phenological, variability.

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## 45 1. INTRODUCTION

46 Bambara groundnut (*Vigna subterranea* [L.] Verdc.) is indigenous to sub-Saharan Africa, where it is widely  
47 cultivated. The centre of origin is most likely Northern Cameroon and North-eastern Nigeria in Africa. In  
48 Southern Africa, Zimbabwe is the centre of production. Bambara groundnut is an annual, creeping legume  
49 with glabrous, trifoliolate leaves. Flowers are presented as papilionaceous racemes. Bambara groundnut  
50 flowering is comprised between 32 and 42 days after sowing [1], 28 and 39 DAS [2]. Fruits are one or 2-  
51 seeded pods, with various size with diameter between 8 to 14 mm [3] and seeds are round, smooth and very  
52 hard when dry. Average yields range from 350 to 800 kg.ha<sup>-1</sup> in the regions where the soil is poor and  
53 rainfalls low [4]. Yields can reach 3000 kg.ha<sup>-1</sup> under controlled conditions with the use of fertilizers [5].  
54 Bambara groundnut adapts easily to difficult climatic condition and poor soils [6]. It is cultivated primarily for  
55 its seeds, which are used as human food. In many traditional cropping systems, it is intercropped with other  
56 root and cereal crops [6]. Bambara groundnut play a role in addressing food insecurity, malnutrition [7] as  
57 protein supplement within rural populations. Seeds are highly calorific (387 kcal/100 g), **The chemical**  
58 **composition of the seeds consists** of 64.4% carbohydrate, 23.6% protein, 6.5% fat, and 5.5% fiber [8, 9, 10].  
59 Besides the nutritional significance of Bambara groundnut could be used for the medicinal purpose [11].

60 In Burkina Faso, Bambara groundnut is the second economically important grain legume [1]. The varieties  
 61 with seed coat cream colour are the most appreciated. Producers, traders and consumers affirm that these  
 62 varieties are aesthetically attractive with a high market value and have a reduced cooking time [12]. This  
 63 perception by producers and consumers is gradually leading to the abandonment of some varieties. This  
 64 resource is seriously threatened by genetic erosion in cultivated fields. Bambara groundnut is grown on small  
 65 surfaces mainly by female farmers and is economically important for producers and traders. In spite of its  
 66 enormous agronomic and nutritional potential it is neglected and underutilized. The literature pertaining  
 67 studies in Bambara groundnut accessions is very limited in Burkina Faso. Except the studies conducted by  
 68 [1, 2, 13] and using morphological markers and [14, 15, 16] using DNA markers, researches are limited on  
 69 this specie. The valorization of any species requires knowledge and the control of its genetic diversity for its  
 70 good exploitation, its improvement, as well as for its safeguard against genetic erosion. Indeed, plant genetic  
 71 resources are the key to food security and sustainable agricultural development [17]. The objective of this  
 72 investigation aims to characterize the level of agromorphological variability of Bambara groundnut genotypes  
 73 from Burkina Faso.

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## 76 2. METHODOLOGIE

### 77 2.1. PLANT MATERIAL AND EXPERIMENT MANAGEMENT

78 This characterization study for determination of the level of the morphological and agronomic variability  
 79 within Bambara groundnut collection on the experimental site of University Center of Tenkodogo. Climate is  
 80 Sudano-sahelian, soil is acidic and characterized by low content of N, P, K. It has a sandy texture in the 0-16  
 81 cm depth and sandy-clay in the 16-36 cm depth, all supported by a plinthite like corresponding to an endo  
 82 petroplinthic lixisol. Experiment was carried out with 20 genotypes from the gene bank of the Institute of the  
 83 Environment and Agricultural Research (INERA). The different genotypes used are listed in Table 1.

84 **Table 1. Name and origin of genotypes**

N°	Name	Origin	N°	Name	Origin	N°	Name	Origin	N°	Name	Origin
1	KVS109A	INERA	6	KVS360	INERA	11	60GYF271	INERA	16	60GYF276	INERA
2	VARFOUR	INERA	7	KVS314	INERA	12	60GYF439	INERA	17	KVS210LR	INERA
3	KVS109B	INERA	8	KVS97-2	INERA	13	60GY301	INERA	18	10VAR360	INERA
4	KVS141-2	INERA	9	KVS311	INERA	14	60GY-F80	INERA	19	KVS075-1	INERA

85 The experimental device used was a completely randomized Fisher blocks with four replications. Each block  
 86 consisted of 20 rows, each elementary row was randomly assigned with a genotype. Each row measured 4  
 87 m length and 21 seed were sown for each genotype per row. The spacings were 0.4 m between row and 0.2  
 88 m between the holes in the row. The blocks were separated by 1 m alley. Investigations were carried out  
 89 during the rainy season 2021. Sowing was done on July 4 in a ploughed soil with one grain per hole after  
 90 preparation of the soil using a tractor on July 1st. Manual weeding on demand followed by mounding on the  
 91 49th days after sowing. The device has not undergone phytosanitary treatment. In sowing, NPK (14-23-14)  
 92 was applied as basal at a dose of 75 kg.ha<sup>-1</sup>.

## 93 2.2. DATA COLLECTION AND ANALYSIS

94 A total of 23 characters (4 qualitative and 19 quantitative) were recorded (Table 2). The choice of the  
 95 different traits and methods of measurement and observation were made according to the Bambara  
 96 groundnut descriptor [18]. Data collection took into account the morphological, physiological and agronomic  
 97 characteristics retained in this study.

100 **Table 2 : Bambara groundnut qualitative and quantitative characters studied**

Character	Code	Notation
<b>Qualitative traits</b>		
Terminal leaflet shape	TLS	-
Seed colour	SCO	-
Presence of eye	POE	-
Colour and appearance of eye	CAE	-
<b>Phenological traits</b>		
Number of days from sowing to 50% plantlet emergence	EMG50	Day
Rate of emerged plants at 21 days after sowing	RES21	%
Number of days from sowing to first flowering	FFL	Day
Number of days from sowing to 50% flowering	FLO50	Day
<b>Vegetative traits</b>		
Number of leaves per plant	NL/P	Number
Plant height	PIH	cm
Plant Spread	PIS	cm
Number of pods per plant	NP/P	Number
<b>Yield related traits</b>		
Number of of pods containing one seed	N1S	Number
Number of of pods containing two seeds	N2S	Number

Weight of pod per plant	WP/P	g
Pod length	PLen	mm
Pod width	PWid	mm
Weight of seeds per plant	WSP	g
Seed length	SLen	mm
Seed width	SWid	mm
100-seeds weight	W100S	g
Pod filling rate	PFR	%
Yield	YLD	Kg.ha <sup>-1</sup>

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101 Data were subjected to the descriptive statistics (mean, coefficient of variation) and analysis of variance  
102 (ANOVA) using XLSTAT 2021 4.1 software. Data analysis was performed with the average values obtained  
103 by rows and by blocks. Analysis of variance was performed to reveal the significant differences between the  
104 genotypes for each trait. The hierarchical ascending classification (HAC) was performed to group the  
105 genotypes according to morphological and agronomic parameters. The study of the relationships between  
106 quantitative traits was carried out using the Pearson correlation matrix to establish the degree of connection  
107 between the quantitative characters with the correlation coefficients.

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### 110 3. RESULTS AND DISCUSSION

#### 111 3.1. VARIATION OF QUALITATIVE AND QUANTITATIVE TRAITS

112 All the qualitative traits studied showed the existence of several modalities (Table 3). Three modalities were  
113 recorded for the terminal leaflet shape. The oval shape was observed for 70% of the genotypes against 25%  
114 laceolate shape and 5% for elliptic shape. Except the round shape, all the different possible shapes  
115 described in the descriptor for Bambara Groundnut [18] are presented in the collection. This testifies to a  
116 good representativeness (75%) of the shape of the terminal leaflet within the collection. The result showed a  
117 high proportion of the cream-colour seeds (45%), followed by red seeds (20%) and purple seeds (15%). This  
118 high proportion of cream-colored seeds is also reported by Kambou et al. and Ouoba et al. [2, 12] which  
119 explains that consumers prefer cream colour seeds for its market value and aesthetics as well as its  
120 relatively low cooking time. The colour of the seeds shows several modalities which testifies to a very great  
121 variability for this character. Kambou et al. and Issa et al. [2, 19] showed that there is an important variability  
122 of the seed colour with Bambara groundnut collected from Burkina Faso and Niger respectively. The

123 presence of the eye was observed in 80% of the genotypes. This high proportion observed within the  
 124 collection is due to the producers and is taken into account for the multiplication and the valuation of their  
 125 accessions according to **Kambou et al.** [2]. These authors also observed a high proportion (74.44%) of  
 126 presence of the eye within a collection of 90 genotypes.

127 **Table 3 : Variation of qualitative traits**

Characters	Variant	Fréquency (%)
Terminal leaflet shape	Elliptic	5
	Oval	70
	Lanceolate	25
Seed colour	Cream	45
	Purple	20
	Cream with triangular dark eye	15
	Dark brown dots on red background	5
	Brown streaks on cream background	5
	Black	5
	Dark brown rhombic spots on a cream background on the micro pillar tip	5
Presence of eye	Present	80
	Absent	20
Colour and appearance of eye	Butterfly-shaped dark brown eye	25
	Butterfly-shaped gray eye	25
	circular brown eye	25
	Butterfly-shaped gray eye	25

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**Figure 1 : Different colour of Bambara groundnut seeds**

140 **Légend** : **A** : Cream, **B** : Dark brown dots on light red background, **C** : Black, **D** : Dark brown rhombic spots  
 141 on a cream background on the micro pilar tip, **E** : Brown streaks on cream background, **F** : Purple,  
 142 **G** : Cream with triangular dark eye

143 The results of analysis of variance for phenological and agronomic quantitative traits are recorded in the  
 144 table 4. The analysis of this table shows low coefficient of variation (CV) values for all phenological traits  
 145 examined. The coefficients of variation is low (CV < 20%) and ranged between 2.57% (FFL) to 12.90%  
 146 (EMG50). The yield and yield-related traits show high value of the coefficient of variation (CV > 20%) for  
 147 number of pods containing two seeds (N2S = 69.67%), weight of seed per plant (WS/P = 25.42%), yield  
 148 (YLD = 24.32%) number of pods per plant (NP/P = 323.47%) and number of pods containing one seed (N1S  
 149 = 22.18%). The analysis of variance carried out for Bambara groundnut genotypes from INERA genebank  
 150 showed that there is a significant difference at the 5% threshold with regard to phenological, vegetative and  
 151 agronomic traits. All the characters analyzed in this study were discriminant and very informative except the  
 152 plant spread (PIS). This high variability corroborates those observed in similar studies by [20] with four local  
 153 populations of Bambara groundnut collecte in Côte d'Ivoire. Highly significant differences were observed in  
 154 the most of the traits. However, characters such as number of days from sowing to 50% plantlet  
 155 emergence (EMG50), number of pods containing one seed (N1S). Pod filling rate (PFR) and pod width  
 156 (PWid) have significant differences. These results show the existence of an important phenological and  
 157 agronomic variability between the genotypes studied, which result from the expression of a strong genotypic  
 158 heterogeneity and the influence of environmental factors [21, 22, 23]. These results corroborate those  
 159 obtained by Djè et al. and Harouna et al. [24, 25]. These authors testified a significant phenotypic variability  
 160 between the accessions from Côte d'Ivoire and Niger respectively.

161 **Table 4 : Analysis of variance of the 19 quantitative parameters of Bambara groundnut genotypes**

<b>Characters</b>	<b>CV (%)</b>	<b>F de Fisher</b>	<b>P-Value</b>	<b>Significance</b>
<b>Phenological traits</b>				
EMG50	12.90	3.32	0.001	S
RES21	12.30	6.54	< 0.001	HS
FFL	2.57	9.83	< 0.001	HS
FLO50	3.16	7.01	< 0.001	HS
<b>Vegetative traits</b>				
NL/P	16.50	7.25	< 0.001	HS
PIH	6.75	3.45	< 0.001	HS
PIS	15.14	1.57	0.098	NS
<b>Yield related traits</b>				
NP/P	23.47	3.85	< 0.001	HS

N1S	22.18	2.61	< 0.003	S
N2S	69.67	3.18	< 0.001	HS
WP/P	17.93	5.03	< 0.001	HS
PLen	3.94	3.54	< 0.001	HS
PWid	4.20	2.04	0.020	S
SLen	4.10	4.56	< 0.001	HS
WS/P	25.42	2.96	< 0.001	HS
SWid	4.81	3.13	< 0.001	HS
W100S	8.12	9.34	< 0.001	HS
PFR	4.21	1.90	0.033	S
YLD	24.32	3.98	< 0.001	S

162 **Legend:** *EMG50* : Number of days from sowing to 50% plantlet emergence ; *RES21* : Rate of emerged  
163 plants at 21 days after sowing ; *FFL* : Number of days from sowing to first flowering *FLO50* : Number of days  
164 from sowing to 50% flowering; *NL/P* : Number of leaves per plant ; *PIH* : Plant height ; *PIS* : Plant Spread ;  
165 *NP/P* : Number of pods per plant ; *N1S* : Number of pods containing one seed ; *N2S* : Number of pods  
166 containing two seeds ; *WP/P* : Weight of pod per plant ; *WS/P* : Weight of seed per plant ; *PLen* : Pod  
167 Length ; *PWid* : Pod width ; *SLen* : Seed Length ; *SWid* : Seed width ; *W100S* : Weight of 100 seeds ; *PFR* :  
168 Pod filling rate ; *YLD* : Yield ; *F* : coefficient of Fischer ; *CV* : coefficient of variation ; *NS* : Not significant ; *S* :  
169 Significant difference at 5% ; *HS* : Hight significant difference at 5%

### 170 3.2. RELATIONSHIP BETWEEN CHARACTERS

171 Pearson correlation matrix showed positive and negative correlations at the 5% threshold among quantitative  
172 characters (Table 5). The knowledge of the relationships between traits is an important and useful approach  
173 for the identification of potential agronomic traits that can be taken into consideration according to the  
174 selection objectives in genetic improvement programs. Most of the negative correlation was observed  
175 between phenological and agronomic traits. The character number of days from sowing to 50% flowering  
176 (*FLO50*) is negatively and significantly correlated ( $-0.70 < r < -0.40$ ) with number of seed in the pod (*N1S*  
177 and *N2S*). It is also strongly and negatively correlated ( $r < -0.70$ ) to the number of pods per plant (*NP/P*),  
178 100-seeds weight (*W100S*), weight of seeds per plant (*WS/P*), and yield (*YLD*). The negative correlations  
179 observed between these characters implies that the traits evolve in the opposite direction [26]. These  
180 negative correlations indicate that plants with an early semi-flowering cycle have very interesting agronomic  
181 characteristics. These results are in agreement with those obtained by [1, 2]. On the other hand, [24]  
182 obtained the opposite results with accessions from Côte d'Ivoire that have very long cycles with interesting  
183 agronomic characteristics. Number of leaves per plant (*NL/P*) was positively and significantly correlated ( $0.40$   
184  $< r < 0.70$ ) with number of pods per plant (*NP/P*), weight of pods per plant (*WP/P*) and weight of seeds per  
185 plant (*WS/P*). Correlations between traits show number of leaves (*NL/P*) are important indices for improving  
186 Bambara groundnut productivity.

187 Selection of Bambara groundnut genotypes with interesting pods parameters should be oriented towards  
188 high number of leaves. In addition, number of leaves, short flowering cycle have a direct effect on the yield  
189 and direct selection based on these characters would be favorable to improve Bambara groundnut yield. The  
190 number of pods containing one seed (N1S) is highly and positively correlated ( $r < 0.70$ ) with the number of  
191 pods per plant (NP/P), weight of pods per plant (WP/P) and weight of seeds per plant (WS/P). The 100-seed  
192 weight (W100S) was strongly and positively correlated ( $r > 0.70$ ) with seed width (SWid), and yield (YLD).  
193 Weight of seed per plant (WS/P) shows a positive and significant correlation ( $r = 0.681$ ) with yield (YLD).  
194 Correlations are an essential tool for breeders because they can facilitate genetic improvement in so far as  
195 when traits are positively correlated, improving one will lead to improving others [27].

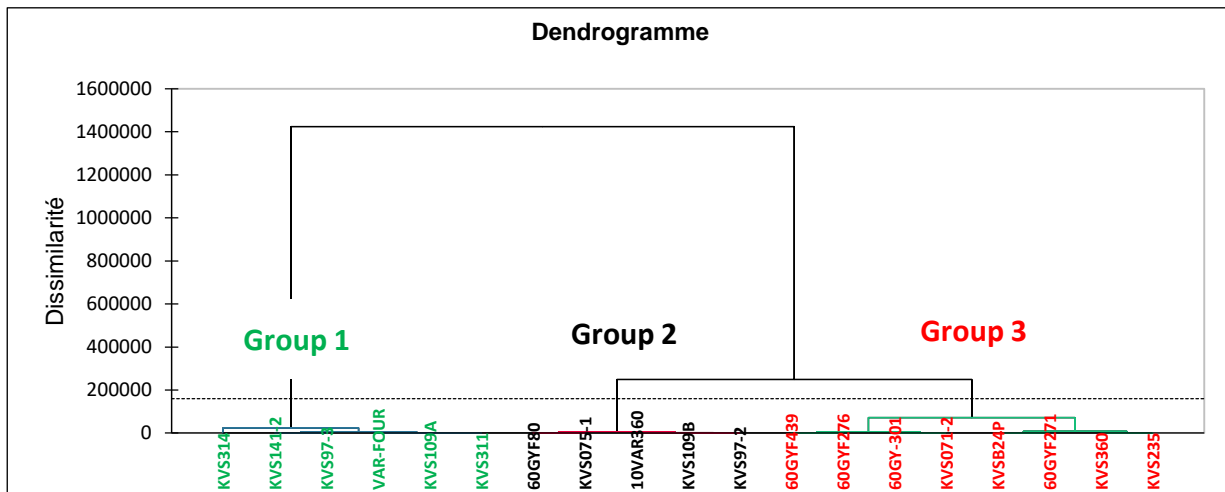
**Table 5 : Pearson's correlations matrice between the 19 quantitative variables**

Variables	EMG50	RES21	FFL	FLO50	NL/P	PIH	PIS	N1S	N2S	NP/P	WP/P	W100S	PLen	PWid	SLen	SWid	PFR	WS/P
<b>RES21</b>	<b>-0.568</b>																	
<b>FFL</b>	0.413	0.121																
<b>FLO50</b>	0.312	0.028	<b>0.857</b>															
<b>NL/P</b>	<b>-0.471</b>	-0.206	<b>-0.650</b>	<b>-0.541</b>														
<b>PIH</b>	-0.214	0.084	0.369	<b>0.581</b>	-0.090													
<b>PIS</b>	0.391	-0.343	0.411	<b>0.526</b>	0.058	<b>0.467</b>												
<b>N1S</b>	0.026	-0.234	<b>-0.574</b>	<b>-0.696</b>	<b>0.592</b>	<b>-0.520</b>	-0.132											
<b>N2S</b>	-0.117	-0.213	<b>-0.634</b>	<b>-0.675</b>	0.454	<b>-0.588</b>	-0.399	<b>0.564</b>										
<b>NP/P</b>	-0.249	-0.098	<b>-0.734</b>	<b>-0.861</b>	<b>0.689</b>	<b>-0.515</b>	-0.286	<b>0.901</b>	<b>0.692</b>									
<b>WP/P</b>	-0.125	-0.356	<b>-0.814</b>	<b>-0.890</b>	<b>0.699</b>	<b>-0.502</b>	-0.223	<b>0.828</b>	<b>0.695</b>	<b>0.892</b>								
<b>W100S</b>	-0.334	0.113	<b>-0.737</b>	<b>-0.802</b>	<b>0.485</b>	<b>-0.460</b>	-0.434	<b>0.627</b>	<b>0.555</b>	<b>0.683</b>	<b>0.737</b>							
<b>PLen</b>	-0.121	-0.136	-0.105	0.178	0.060	<b>0.553</b>	0.379	-0.272	-0.298	-0.263	-0.108	0.063						
<b>PWid</b>	0.143	-0.326	-0.179	0.069	0.113	0.263	0.417	-0.086	-0.128	-0.133	0.058	0.127	<b>0.847</b>					
<b>SLen</b>	0.023	-0.080	-0.404	-0.354	-0.049	-0.119	-0.132	0.028	-0.006	0.062	0.287	<b>0.548</b>	<b>0.616</b>	<b>0.649</b>				
<b>SWid</b>	-0.344	-0.060	<b>-0.775</b>	<b>-0.733</b>	<b>0.612</b>	-0.435	-0.306	<b>0.594</b>	<b>0.529</b>	<b>0.682</b>	<b>0.780</b>	<b>0.873</b>	0.202	0.309	<b>0.594</b>			
<b>PFR</b>	<b>-0.456</b>	0.308	-0.433	-0.439	0.288	-0.240	-0.317	0.204	0.134	0.433	0.313	0.369	0.017	0.044	0.301	<b>0.506</b>		
<b>WS/P</b>	-0.022	-0.420	<b>-0.759</b>	<b>-0.845</b>	<b>0.595</b>	<b>-0.472</b>	-0.210	<b>0.757</b>	<b>0.660</b>	<b>0.783</b>	<b>0.948</b>	<b>0.652</b>	-0.100	0.062	0.271	<b>0.663</b>	0.057	
<b>YLD</b>	-0.343	0.287	<b>-0.668</b>	<b>-0.814</b>	0.404	<b>-0.553</b>	<b>-0.471</b>	<b>0.615</b>	<b>0.540</b>	<b>0.684</b>	<b>0.703</b>	<b>0.869</b>	-0.183	-0.095	0.345	<b>0.745</b>	0.328	<b>0.681</b>

**Legend:** *EMG50* : Number of days from sowing to 50% plantlet emergence ; *RES21* : Rate of emerged plants at 21 days after sowing ; *FFL* : Number of days from sowing to first flowering *FLO50* : Number of days from sowing to 50% flowering; *NL/P* : Number of leaves per plant ; *PIH* : Plant height ; *PIS* : Plant Spread ; *NP/P* : Number of pods per plant ; *N1S* : Number of pods containing one seed ; *N2S* : Number of pods containing two seeds ; *WP/P* : Weight of pod per plant ; *WS/P* : Weight of seed per plant ; *PLen* : Poda Length ; *PWid* : Pod width ; *SLen* : Seed Length ; *SWid* : Seed width ; *W100S* : Weight of 100 seeds ; *PFR* : Pod filling rate ; *YLD* : Yield

### 3.3. ORGANIZATION OF THE VARIABILITY AND CHARACTERISTICS OF THE GROUPS

The hierarchical ascending classification (HAC) carried out using Euclidean distances with the Ward method as the aggregation criterion is represented by the dendrogram in the figure 2. This study has allowed to obtain an organization of the genotypes in three different groups on the basis of the physiological, phenological and agronomic traits. These results could be explained by the variability of this species and testify to morphometric and agronomic diversity within the collection. The unidirectional test of mean equalities of the groups showed the gathering of the genotypes is based mainly on characters such as number of days from sowing to 50% flowering (FLO50 ;  $P < 0.0001$ ), plant spread (PIS;  $P < 0.05$ ), number of pods per plant (NP/P;  $P = 0.000$ ), 100-seeds weight (W100S;  $P < 0.0001$ ), seed width (SWid;  $P < 0.0001$ ), (WS/P = 0.002) and yield (YLD;  $P < 0.0001$ ). The group 1 (in green colour) is composed of six genotypes. The group 2 (in black colour) is composed of five genotypes and the group 3 (in red colour) being the most supplied group with eight genotypes. This result corroborated those of [Diagara et al.](#) [28] who obtained three groups with 30 accessions from Niger. However it is different of the findings reported by [Bonny and Djè](#) [23] who obtained four distinct groups with 101 accessions from Côte d'Ivoire, and the most relevant variables to describe the variability between these groups were internode length, pod length, plant height and cycle length. [Issa et al.](#) [29] have also obtained four groups with accessions from Niger. The four different group could be due to the high number of accessions used in their study.



**Figure 2 : Dendrogram showing the clustering pattern in Bambara groundnut genotypes**

The results showed that the the genotypes of the group 1 is the lesser performant. They have very low values of yield and yield components. In addition they take more time to emerged (EMG50 = 7 days) and to flower (FLO50 = 37,42 days). The group 2 contains the most productive genotypes. It is characterized by

genotypes with earlier flowering (FLO50 = 34.4 days) and high values of 100-seeds weight (W100S = 59.45 g), seed width (SWid = 9.04 mm), weight of seed per plant (WS/P = 17.58 g) and yield (YLD = 1597.50 kg.ha<sup>-1</sup>). Five promising accessions KVS109B, KVS97-2, 60GYF80, 10VAR360 and KVS075-1 based on their agronomic and physiological performance were identified and could be taken into account in a possible Bambara groundnut improvement program.

#### **4. CONCLUSION**

The analysis of variance indicated significant differences within the Bambara groundnut genotypes for the 19 characters studied. Correlations between variables showed that yield is correlated with most of the agromorphological parameters used in this study. The hierarchical ascending classification showed that Bambara groundnut genotypes can be classified into three distinct groups. Group 1 is one characterized by a long crop cycle and taller plants. This group is opposed to group 2 with interesting yield component and high yield. The variability expressed among INERA genebank genotypes can be exploited in Bambara groundnut breeding programs. Most of the negative correlation was observed between phenological and agronomic traits. However, several correlations are positive and many significant correlations have been observed between the characters related to yield. **Selection of Bambara groundnut genotypes with interesting yield should be oriented toward 100-seeds weight, weight of seed per plant and seed width.**

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#### **COMPETING INTERESTS**

Authors declare no competing interests.

#### **AUTHORS' CONTRIBUTIONS**

The concept, design, and methods of the paper were constructed by Hervé NANDKANGRE, Koulibi Fidèle ZONGO and Diane Judicaëlle KAMBOU. Data collection was carried out by Barkoindé Yannick ILBOUDO, Hervé NANDKANGRE, Koulibi Fidèle ZONGO. Statistical analysis software and interpretation were undertaken by Hervé NANDKANGRE, Koulibi Fidèle ZONGO and Diane Judicaëlle KAMBOU. Writing original draft preparation of the manuscript was carried out by Hervé NANDKANGRE. Review and editing by Aimé Sévérin KIMA, Hamed Mahamadi OUEDRAOGO, OUOBA Adjima, Moussa N'Golo KONATE, Ernest Renan TRAORE. Supervision by Mahama OUEDRAOGO. All authors have read and agreed to the published version of the manuscript.

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