Available online at http://www.ifgdg.org

Int. J. Biol. Chem. Sci. 19(3): 1098-1111, June 2025

ISSN 1997-342X (Online), ISSN 1991-8631 (Print)

International Journal of Biological and Chemical Sciences

Original Paper http://ajol.info/index.php/ijbcs http://indexmedicus.afro.who.int

Agromorphological characterization of groundnut (*Arachis hypogaea* L.) accessions in Northern Côte d'Ivoire

Bi Tra Achille IRIE, Inza Jesus FOFANA and Yacouba BAKAYOKO*

Université Peleforo Gon Coulibaly de Korhogo (UPGC), UFR Science Biologique, UPR de Génétique, BP 1328 Korhogo, Côte d'Ivoire.
**Corresponding author; E-mail: yacfehler@gmail.com; Phone: +225 07 07595356*

Received: 08-10-2024 Accepted: 26-06-2025 Published: 30-06-2025

ABSTRACT

Arachis hypogaea L., better known as groundnut, is an annual leguminous plant, cultivated for its oil seeds. In Cote d'Ivoire, groundnut production used to be geared towards local consumption, but a is now being export. In order to support this trend, the present study was initiated with the aim of assessing the phenotypic diversity of the agromorphological traits a few cultivated varieties. A total of 57 groundnut accessions collected in the north and center-west of the country were cultivated in the Botanical Garden of Peleforo Gon Coulibaly University. The system used was a randomized Fisher block with three replications, and 26 agronomic and morphological parameters were measured. The results showed considerable variability between accessions in terms of vegetative and production parameters, such as the weight of 100 dry seeds, dry pods yield and dry seed yield. In addition, the number of days to flowering, the number of primary branches, the number of days to maturity and the weight of 100 dry seeds were the key parameters for the identification of ideal accessions for higher yield. Thus, information on accessions, on identical characteristics in terms of yield, could contribute to peanut genetic improvement of groundnut in future breeding work in order to meet growers' expectations.

Keywords: Groundnut accessions; Diversity; Yield; Northern Côte d'Ivoire.

INTRODUCTION

The groundnut plant (*Arachis hypogaea* L.) belongs to the legume family (Fabaceae), which originated in Mexico and is cultivated for its oilseeds (Maliki et al., 2020). It is grown in more than 100 countries in tropical, subtropical and warm temperate regions (Guchi et al., 2014). Groundnut represent one of the most important oilseed crops in the world. In much of sub-Saharan Africa, groundnut is an important crop for domestic consumption, trade and fodder (Christie et al., 2015).

The main producers are China and India, which supply over 60% of world production. Africa accounts for 25% of production, mainly by Nigeria, Senegal and Sudan (Noba et al., 2014). Côte d'Ivoire remains a small producer worldwide, with production estimated at 227.571 tons (FAOSTAT, 2020). Nearly half of this production is shipped to the city of Abidjan (43%), the rest distributed to other cities (Koné et al., 2019). However, in recent years, new and more profitable markets in neighboring countries such as Mali and Burkina Faso have been supplied with groundnut from Côte d'Ivoire. As a result, groundnut production is needs to be stepped up for anticipation of future shortages for stakeholders in the sector. The use of high-yielding varieties could significantly increase groundnut productivity. This requires the development of a productivity improvement programme based on the available genetic diversity of groundnut, especially given the presence of foreign varieties in seed lots (Ndoye et al., 2024). However, little is known about the agro-morphological characteristics of the ecotypes and/or exotic germplasm found in Côte d'Ivoire. The interest in growing high-performance groundnut a from different agro-climates calls for a mapping of the ecotypes grown, in order to select the best ones to satisfy growers. In this context, the aim of this study was to assess the phenotypic diversity of the agromorphological characteristics of a few cultivated varieties.

MATERIALS AND METHODS

Experiment site

The studies were carried out in 2021 in the vegetable garden of the botanical garden of Peleforo Gon Coulibaly University in Korhogo, a town in northern Côte d'Ivoire. The geographical coordinates of the area are 9°27’28” North, longitude 5°37’46” West and altitude 360 m. The local climate is marked by two alternating seasons. The dry season is marked by the harmattan between December and January, with heat peaking in March and April. The rainy season extends from May to October with maximum rainfall in July and August (Boko-Koiadia et al., 2016).

Plant material

The plant material consisted of the seeds of 57 groundnut accessions. These groundnut accessions were collected in the form of dry pods in the north and center-west of Côte d'Ivoire, more specifically in the departments of Bouaké, Yamoussoukro, Korhogo, Kong, Ouangolodougou, Dabakala, Dikodougou, Ferkessédougou, Mankono, Odienné, Madinani, Minignan, Boundiali, Kouto and Zuenoula.

Methods

The expenment was conducted using a randomized Fisher block design, with three replicates. The blocks were 1 m apart and comprised three ridges. On one block, the distance between accessions was 0.25 m. An accession comprising 10 plants was divided into two rows of five on a ridge and a sub-plot. The experimental set-up covered an area of 570 m^2 (15 m x 38 m). During sowing, 2 groundnut seeds were planted per stake. The seeds were removed 15 days later, to keep only the most vigorous plant. Regular weeding was carried out to keep the plot clean. No pesticides or fertilizers were applied during the experiment.

Observations and measurements

Observations were made according to the indicators in the list of groundnut descriptors (IBPGR et al., 1992). Data were collected from the semi-dwarf stage to harvest. For each accession, observations were made on five plants taken at random from two rows for each replication, i.e. 15 plants in total. Ten qualitative variables (Table 1) and 16 quantitative variables (Table 2) were accessed.

Analyses of data generated from qualitative characteristics

For the qualitative parameters, standardised Shannon diversity indices (H’) ranging from 0 to 1 (Baudouin and Santos, 2005) were determined in order to assess the variability in groundnuts.

When H’ tends to 1, the diversity of the character is high. When D tends towards 0, the probability that two accessions drawn at random from the group of groundnut accessions studied have the same phenotype for a given trait is low. In other words, the variability of the trait is high (Yao et al., 2020). These indices have the formula:

$$H' = -\sum_i^n \left(\frac{Ni}{N}\right) x \ln\left(\frac{Ni}{N}\right) / \ln(n) \quad ;$$

$$D = \sum_i^n Ni\,(Ni - 1)\,/N(N - 1)$$

With Ni: the number of modalities observed for a given descriptor, N: the total number of individuals and n: the number of modalities for a characteristic. To test the equiprobability of the appearance of the modalities of a given qualitative trait, a Chi-2 test was performed at the 0.05 significance level. These relative frequencies made it possible to know the mode (most frequent or abundant phenotype) of the different qualitative characters used. The statistical processing of the data was carried out using the Statistical Package of Social Sciences (SPSS) software version 22.0 IBM corp., USA. The variability of quantitative characteristics was assessed using descriptive statistics parameters such as the mean, standard deviation, coefficient of variation (CV) and range. From the standardized data matrix, a correlation matrix was calculated between the variables (Person correlation). To structure the groundnut accessions, a Principal Component Analysis (PCA) was performed. This analysis was followed by a Hierarchical Ascending Classification (HAC) using XLTAT version 2016 to group the accessions studied according to their degree of similarity on the basis of Ward's aggregation criteria performed with STATISTICA software version 7.1 (Statstoft, France, 2005).

Table 1: Quantitative parameters used for the agro-morphological characterization of 57 groundnut accessions.

Plant and production parameters		
Character (SI)	Codes	Measurement methods
Beak of the pod	Spout	Observed after drying the seeds on 5 pods.
Strangulation the pod	Etr	Observed after drying of seeds on 5 pods.
Cross-linking of the pod	Ret	Observed after drying of seeds on 5 pods.
Colour of the seed	ClrGr	Observed one month after drying on 5 seeds.

Table 2: Quantitative characters used for the agromorphological characterisation of 57 groundnut accessions.

Phenological parameters, Vegetative parameters and production parameters		
Character (SI)	Codes	Measurement methods
Emergence time seedlings	Tem	Obtained by counting by evaluating the number of days elapsed until the seedlings emerge.
Number of days to flowering	NFL	Determined by measuring the number of days from sowing to seedlings flowering.
Number of days of maturity	NJM	Obtained by counting the number of days from sowing the physiological maturity of the plants.
Span of plant (mm)	EP	Measured in mm using a tape measure between the extreme points of the width, from one end of the branches to the other, on the 45th day after emergence.

Height of the main stem (mm)	HT	Using a tape measure, the height of the plant was measured from the collar to the tip of the last leaf on the plants on the 60th day after emergence.
Number of primary branches	NBPr	Obtained by manually counting of primary branches on the 70th day after emergence.
Number of secondary branches	NBS	Obtained by manually counting of secondary branches on the 70th day after emergence.
Number of seeds per pod	NGr_G	Obtained by counting the number of seeds per plant after harvest.
Pod length (mm)	LonG	Measured in mm using a calliper. Measurements are taken on 5 pods per accession.
Pod width (mm)	LarG	Measured in mm using a calliper.Measurements are taken on 5 pods per accession.
Seed length (mm)	LonGr	Measured in mm using a caliper. Measurements are taken on 5 Seeds considered per accession.
Seed width (mm)	LarGr	Measured mm using a caliper. Measurement is taken on 5 Seeds considered per accession.
Weight of one hundred (100) dried pods (g)	PS100G	Measured in g using a precision electronic balance 0.001 g on pods dried in the open air for 5 days at a frequency of 9 h per day (8 to 5 p.m.) per individual.
Weight of one hundred (100) dry seeds (g)	PS100Gr	Measured in g using a precision electronic balance 0.001 g on seeds from dry pods.
Dry pod yield (kg/ha)	RGs	Is obtained from the ratio between the dry pod mass of each plant per cultivar and the area of the field per hectare (RGs = MGs x sp x 0.001).
Seed yield (kg/ha)	RGrs	Is obtained from the ratio between the dry mass of seed of each plant per cultivar and the area of the field per hectare (RGs = MGrs x sp x 0.001).

RESULTS

Analysis of qualitative characteristics

Observations made on the pods and seeds revealed that the characteristics of the pods were fairly heterogeneous. In the expression of pod beak phenotypes, the pronounced phenotype was in the majority with 40.09% followed by the moderate phenotype with 35.99% (Table 3). Less than 11% of individuals expressed the thin, beak without pod and very pronounced phenotypes. For the pod constriction trait, the majority of individuals expressed the unrestricted phenotype at a frequency of 47.83%, followed by the moderate phenotype at 24.7% and the light phenotype at 20.84% (Figure 1). For this trait, individuals expressed less than 5% of the deep and very deep phenotypes (Table 3). In the expression of the five modalities of pod reticulation, the most frequent phenotype was the light phenotype with a frequency with of 49.49%. The moderate, prominent, very prominent and podless phenotypes followed with 21.12, 17.32, 8.8 and 0.47% respectively. The seeds gave a fair amount of color. The most common were seeds with a light tan coloration with 49.19% (Figure 2).

For all the qualitative traits linked to pod and seed, the standardized Shannon diversity indices were greater than 0.5. The indices ranged from 0.67 to 0.86. Seed color and seed shape had the highest standardized Shannon diversity indices, at 0.86 and 0.83 respectively. Simpson's index values ranged from 0.21 to 0.32. It was relatively low for the characters seed color (D = 0.21), seed reticulation (D = 0.24) and pod constriction (D = 0.25), which means that the probability of two accessions drawn at random from the collection having the same morphologies is low (Table 3).

Descriptive analysis according to quantitative characteristics

Table 4 shows the mean, minimum, maximum values, standard deviation, and coefficients of variation of each variable. Six variables showed a high degree of variation (CV ≥ 25%). These were the number of primary branches (NBPr: CV=30.03%), the number of secondary branches (NBs: CV=79.25%), the weight of 100 dry pods (P100Gs: CV=25.8%), the weight of 100 dry seeds (P100Grs: CV =25.9%), the yield of dry pods (RGs: CV = 26%) and the yield of dry seeds (RGrs: CV = 25.33%). Relatively large differences were observed between the minimum and maximum values for these six characteristics. In particular, the weight of 100 dry pods varied from 2 to 20 g, dry pods yield varied from 150 to 2133 kg/ha and the yield of dry seeds varied from 54.08 to 978 kg/ha. All the traits assessed discriminated significantly.

Correlation between the agromorphological characters of peanut accessions

Correlation and significance tests on quantitative characteristics noted a positive correlation between the various production characteristics (Table 5). In this study, the strongest correlations were between dry seed yield (RGrs) and the dry pods yield (RGs) with significance ($r = 0.91$ with $p < 0.001$), and between the dry seed yield (RGrs) and the weight of 100 dry seeds (P100Grs) with significance ($r = 0.9$ with p =< 0.001). A positive and significant correlation ($r = 0.91$ with $p < 0.001$) was observed between the weight of 100 dry seeds (P100Gsr) and the weight of 100 dry pods (P100Gs). Accessions with a high number of days to maturity gave a good dry pod yield ($r = 0.89$ with $p < 0.001$).

Principal component analysis

Examination of the factorial weight matrix revealed the first three components which explained 75.28 % of the variability observed. The first two components (axes 1 and 2) were selected to explain the variability within the accessions. These two axes explained 64.46 % of the total variability.

The first component explained 39.97% of the variability. It is defined by production characteristics such as pod length (LonG), pod width (LarG), weight of 100 dry pods (P100Gs), weight of 100 dry seeds (P100Grs), dry pods yield (RGs) and dry seed yield (RGrs). Table 6 shows the contribution of each variable to the formation of the three PCA axes. The second axis expressed 24.49% of the variation. Only vegetative characteristics contributed to the definition of this axis. These were number of days to flowering (NJFL), number of primary branches (NBPr), number of secondary branches (NBS) and number of days to maturity (NJM). The third component (axis 3) which absorbed 10.82% of the variability, was correlated with the plant span (EP).

Diversity analysis using Ascending Hierarchical Clustering

The dendrogram of the Hierarchical Ascending Classification (HAC) constructed Ward's method at the Euclidean distance of 100 made it possible to identify three groups of homogeneous accessions (Figure 3). The mean silhouette of the first group of 22 individuals was 0.38. That of the second group, made up of 19 individuals, was 0.33. The third group consisted of 16 individuals with an average of 0.28. The morphological groups identified included accessions of various origins.

Analysis of the data showed diversity in 14 of the sixteen traits assessed. Group I was distinguished mainly by plants with a short number of days to flowering (NJF = 29.54 ± 1.34), with a very small number of primary and secondary branches (NBPr = 7.98 ± 1.96 and NBs = 1.54 ± 3.55). This group was also distinguished by plants having a short production cycle (number of days to maturity =119.59 ± 7.95 or 120 days), with small pods (LarG =11.73 ± 0.73 mm) and an average weight of 100 dry seeds (P100Grs = 3 ± 0.42 g). Group II was represented by plants with a long flowering cycle (33.18 ± 1.11 or 33 days) with an average number of primary and secondary branches (NBPr = 13.97 ± 2.01 and NBs = 14.67 ±4.40). This group is differentiated by plants having a late production cycle (number of days to maturity =142.87 ± 4.26 or 142 days), with medium pods (LarG =12.67 ± 0.42 mm) and a low weight of 100 dry seeds (P100Grs = 2.92 ± 0.44 g). Group III was characterized by plants with an average number of flowering days (NJFL = 32.40 ± 1.85, with a high number of primary and secondary branches (NBPr = 14.81 ± 1.89 and NBs = 12.93 ± 4.32). This group of accessions also produced plants with an average production cycle (number of days to maturity = 139.63 ± 9.01 or 140 days), large pods (LarG = 12.86 ± 0.44 mm) and a high weight 100 of dry seeds (P100Grs = 3.51 ± 0.45 g) (Table 7).

Table 3: Descriptive statistics of qualitative variables.

Qualitative characteristics	**Modalities**	**Numbers**	**Frequency (%)**	**Chi2 ($\chi 2$)**	**P**	**H'**	**D**
Beak of the pod	Slim	128	10.1	1419	<0.001	0.83	0.32
	Moderate	456	35.99				
	Pronounced	508	40.09				
	Without	91	7.8				
	Very pronounced	84	6.63				
Strangling the pod	Without	606	47.83	910	<0.001	0.77	0.25
	Moderate	313	24.7				
	Slight	264	20.84				
	Very Deep	24	1.89				
	Deep	60	4.74				
Cross-linking of the pod	Slight	596	49.84	1703	<0.001	0.86	0.24
	Moderate	295	21.12				
	Prominent	200	17.32				
	Without	57	2.92				
	Very prominent	119	8.8				
Seed colour	Red	47	3.64	1590	<0.001	0.67	0.21
	Year	212	16.42				
	Light tan	635	49.19				
	Tinted white	228	17.67				
	White	12	0.93				
	Dark tan	81	6.27				
	Rose	6	0.46				
	Salmon	63	4.88				
	Dark red	6	0.46				

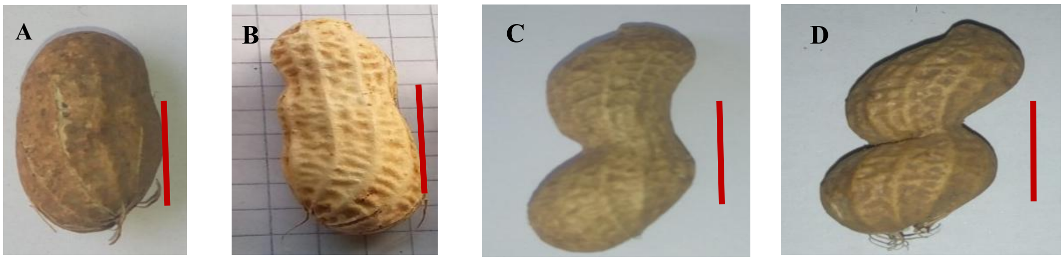

Figure 1 (A-D): Local varietal diversity according to pod constriction.
A= Unrestricted; **B**= Slight; **C**= Deep; **D**= Very deep
Scale: a bar measures 5cm.

Table 4: Descriptive analysis of quantitative characteristics.

Escriptors	Minimum	Maximum	Mean	Standard deviation	CV (%)	F	P
Tem	5.68	10.63	7.33	0.92	12,58	4.19	0.032
NJF	27.38	36.33	31.55	2.28	7,23	18.83	<0.001
EP	18.64	40.05	28.62	4.67	16,32	5.57	0.001
HT	10.4	32.31	22.43	4.64	20,7	16.95	<0.001
NBPr	5.33	17.68	12.22	3.67	30,03	30.56	<0.001
NBS	0	23.6	9.36	7.42	79,25	42.53	<0.001
NJM	107	150.25	132.93	13.32	10,02	55.94	<0.001
NGr_G	2	3	2.03	0.23	11,35	6.26	0.001
LonG	20.41	33.77	26.85	2.9	10,79	4.77	0.04
LarG	10.93	13.67	12.34	0.72	5,89	16.98	<0.001
LonGr	11.15	19.6	13.72	1.54	11,28	21.02	<0.001
LarGr	6.8	12.89	8.16	0.85	10,46	2.6	0.001
P100Gs	2	20	9.69	2.52	26	14.93	<0.001
P100Grs	1	5	3.13	0.81	25,8	14.73	<0.001
RGs	150	213	162.1	42.9	25,9	15	<0.001
RGrs	54.08	978	522.84	132.3	25,35	14.77	<0.001

Tem:time to emergence, **NJF**: number of days to flowering, **EP**: span of the plant, **HT**: Height of the stem, **NBPr**: Number of primary branches, **NBS**: Number of secondary branches, **NJM**: Number of days to maturity, **NGr_G**: number of seeds per pod, **LonG**: Length of the pod, **LarG**: width of the pod, **LonGr**: Length of the seed, **LarGr**: Width of the seed, **P100Grs**: weight of one hundred dry seeds, , **P100GSs**: weight of one hundred dry pods, **RGs**: Dry pod yield, **RGsr**: Dry seed yield, **CV**: coefficient of variation, **F**: statistical value of the V-test, **p**: probability of the test.

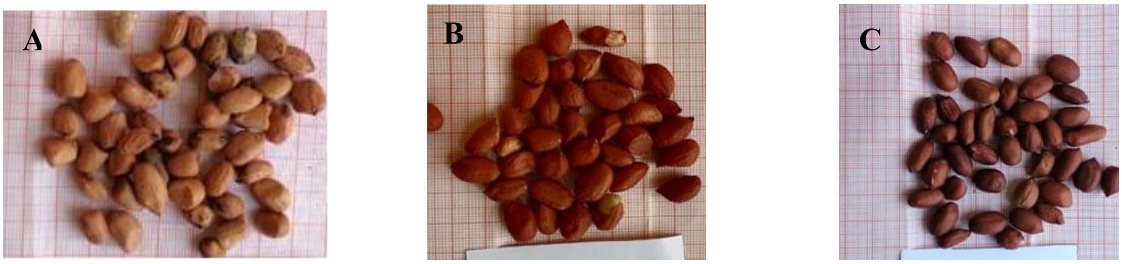

Figure 2 (A-C): Local groundnut varietal diversity according to seed colour expression.
A: Accession with white seeds; **B**: Accession with red seeds; **C**: Accession with light tanned .

Table 5: Pearson correlation matrix (r) between the 16 agromorphological parameters analyzed.

	Tem	NJF	EP	HT	NBPr	NBS	NJM	LonG	LarG	LonGr	LarGr	NGr_G	P100Gs	P100Grs	RGs	RGsr
Tem	1															
NJF	0.17	1														
EP	-0.3	-0.2	1													
HT	-0.3	**-0.53**	**0.58**	1												
NBPr	-0.1	**0.64**	**0.33**	-0.14	1											
NBS	-0.1	**0.77**	0.16	-0.34	**0.84***	1										
NJM	0.13	**0.79**	-0.006	-0.42	**0.8***	**0.88***	1									
LonG	-0.2	0.23	0.005	0.11	0.28	0.17	0.21	1								
LarG	0.05	**0.63**	0.29	-0.13	**0.72***	**0.69**	**0.67**	0.4	1							
LonGr	-0.2	0.34	0.14	-0.01	0.42	0.32	0.32	0.4	0.37	1						
LarGr	0.03	**0.57**	0.25	0.07	**0.58**	**0.62**	**0.56**	0.08	**0.65***	0.26	1					
NGr_G	-0.1	-0.03	-0.04	0.25	0.12	-0.003	-0.14	**0.65***	0.26	0.17	0.1	1				
P100Gs	-0.1	0.08	0.21	0.38	0.24	0.13	0.12	**0.56**	0.49	0.41	0.41	**0.55**	1			
P100Grs	0.06	0.08	0.21	0.38	0.24	0.13	0.12	**0.56**	0.49	0.41	0.41	**0.55**	**0.91***	1		
RGs	-0.1	0.08	0.21	0.38	0.24	0.13	0.12	**0.56**	0.49	0.41	0.41	**0.55**	**0.88***	**0.87***	1	
RGrs	-0.1	0.08	0.21	0.35	0.24	0.13	0.12	**0.56**	0.49	0.41	0.41	**0.55**	**0.89***	**0.9***	**0.91***	

The correlation values (r) in bold are the most significant ($P < 0.05$). **Tem**: emergence time, **NJF**: number of days to flowering, **EP**: span of the plant, **HT**: Height of the stem, **NBPr**: Number of primary branches, **NBS**: Number of secondary branches, **NJM**: Number of days to maturity, **NGr_G**: number of seeds per pod, **LonG**: Length of the pod, **LarG**: width of the pod, **LonGr**: Length of the seed, **LarGr**: Width of the seed, **P100Grs**: weight of one hundred dry seeds, , **P100GSs**: weight of one hundred dry pods, **RG**s: Dry pod yield, **RGsr**: Dry seed yield, **CV**: coefficient of variation, **F**: statistical value of the V-test, **p**: probability of the test

Table 6: Correlation between variables and the three principal components.

Variables	Axis 1	Axis 2	Axis 3
Tem	0.067	0.169	-0.507
NJF	-0.502	**0.749**	-0.191
EP	-0.267	-0.188	**0.833**
HT	-0.146	**-0.721**	0.517
NBPr	-0.672	0.555	0.295
NBS	-0.592	**0.719**	0.161
NJM	-0.566	**0.749**	-0.020
LonG	**-0.628**	-0.212	-0.367
LarG	**-0.803**	0.357	0.022
LonGr	-0.575	0.061	0.025
LarGr	-0.674	0.3182	0.249
NGr_G	-0.505	-0.420	-0.360
P100Gs	**-0.852**	-0.491	-0.091
P100Grs	**-0.842**	-0.481	-0.103
RGs	**-0.854**	-0.493	-0.092
RGrs	**-0.847**	-0.486	-0.105
Equity	6.39	3.91	1.73
Variability (%)	39.97	24.49	10.85
Cumulative %	39.97	64.46	75.28

Tem: Emergence time, **NJF**: number of days to flowering, **EP**: plant span, **HT**: Stem height, **NBPr**: Number of primary branches, **NBS**: Number of secondary branches, **NJM**: Number of days to maturity, **NGr_G**: number of seeds per pod, **LonG**: Length of the pod, **LarG**: width of the pod, **LonGr**: Length of the seed, **LarGr**: Width of the seed, **P100Grs**: weight of one hundred dry seeds, **P100GSs**: weight of one hundred dry pods, **RGs**: Dry pod yield, **RGs**r: Dry seed yield

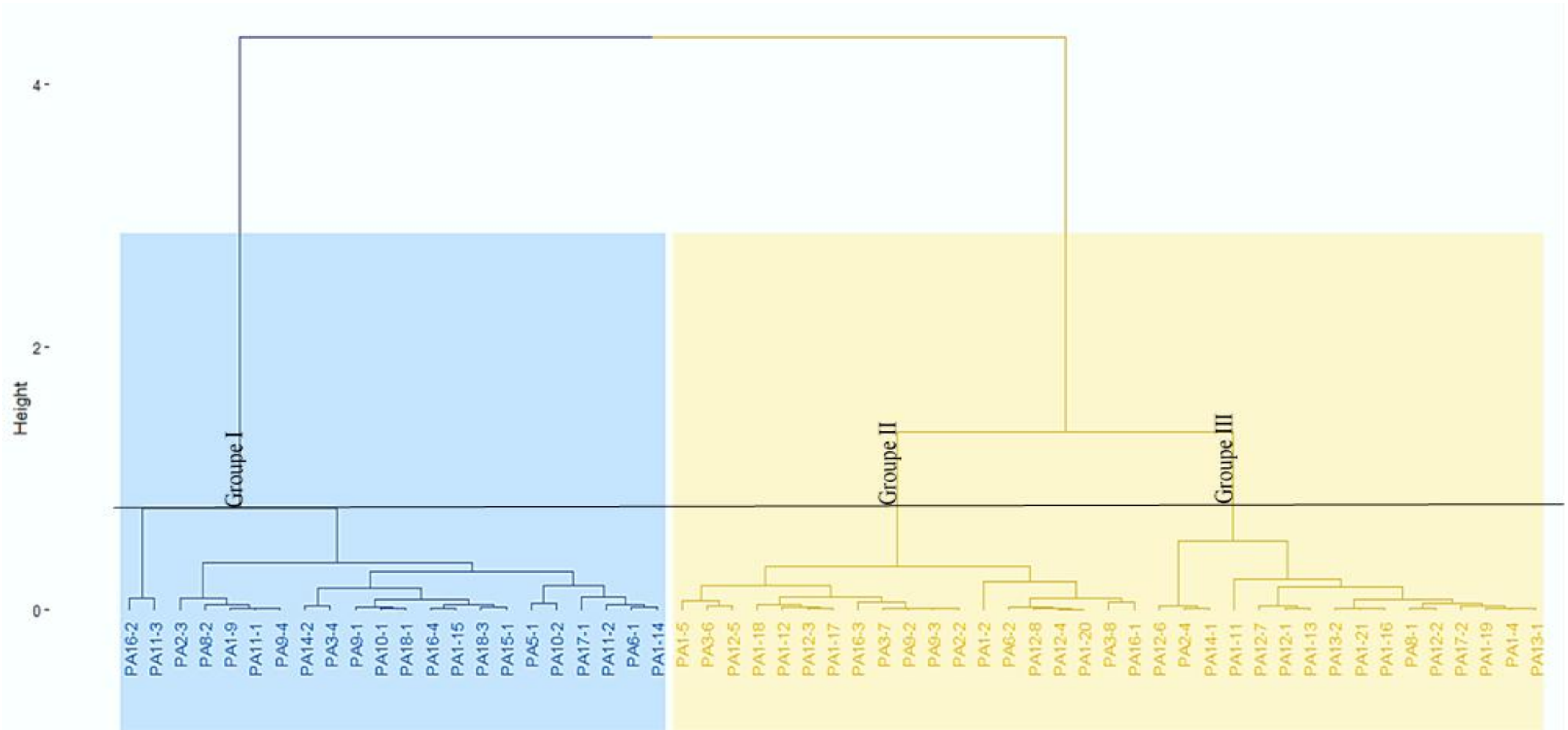

Figure 3: Dendrogram of variability relationship between groundnut accessions based on 16 quantitative characters.

Table 7: Average performance of groups of accessions formed by CAH.

Characteristics	Group 1	Group II	Group III	F	P
Tem	7.57 ± 0.89	7.43 ± 1.01	7.28 ± 0.84	0.457	0.635
NJF	29.54 ± 1.34	33.18 ± 1.11	32.40 ± 1.85	34.767	<0.001***
EP	27.30 ± 4.74	28.06 ± 4.39	29.09 ± 3.80	0.770	0.467
HT	23.83 ± 2.95	18.28 ± 4.23	24.02 ± 3.52	15.117	0.001
NBPr	7.98 ± 1.96	13.97 ± 2.01	14.81 ± 1.89	71.562	<0.001***
NBS	1.54 ± 3.55	14.67 ± 4.40	12.93 ± 4.32	59.917	<0.001***
NJM	119.59 ± 7.95	142.87 ± 4.26	139.63 ± 9.01	58.775	<0.001***
LonG	25.73 ± 2.89	26.32 ± 2.60	30.36 ± 4.21	11,079	0.001
LarG	11.73 ± 0.73	12.67 ± 0.42	12.86 ± 0.44	21.656	<0.001***
LonGr	12.59 ± 1.36	14,25 ± 0.93	14.52 ± 1.33	14.056	0.001
LarGr	7.71 ± 0.42	8.24 ± 0.67	838 ± 0.40	8.846	0.001
NGr_G	2.01 ± 0.22	1.89 ± 0.14	2.24 ± 0.23	12.486	0.001
P100Gs	9.33 ± 1.33	9.10 ± 1.36	10.92 ± 1.40	11.403	0.001
P100Grs	3 ± 0.42	2.92 ± 0.44	3.51 ± 0.45	10.402	<0.001***
RGs	1555.20 ± 222.54	1517.85 ± 228.88	1821.02± 234.13	10.540	0.001
RGrs	500.70 ± 71.64	487.08 ± 73.72	519.81 ± 83.61	10.621	0.001

P < 0.001: Very highly significant probability***; P < 0.01: Highly significant probability**; P < 0.05: Significant probability*
Tem: time to emergence , **NJF**: number of days to flowering, **EP**: span of the plant, **HT**: Height of the stem, **NBPr**: Number of primary branches, **NBS**: Number of secondary branches, **NJM**: Number of days to maturity, **NGr_G**: number of seeds per pod, **LonG**: Length of the pod, **LarG**: width of the pod, **LonGr**: Length of the seed, **LarGr**: Width of the seed, **P100Grs**: weight of one hundred dry seeds, , **P100GSs**: weight of one hundred dry pods, **RGs**: Dry pod yield, **RGsr**: Dry seed yield, **CV**: coefficient of variation, **F**: statistical value of the V-test, **p**: probability of the test.

DISCUSSION

In this study, several discriminating characteristics were highlighted through the agromorphological evaluation of 57 groundnut accessions. This shows that there is a considerable morphological diversity within the accessions studied. The agromorphological characterization enabled the existing diversity to be assessed on the basis of qualitative characteristics from the vegetative stage through to ripening. The qualitative characteristics studied showed a high level of variability between groundnut accessions. This variability is reflected in Simpson indices that are below average (0.5). This indicates the existence of accession variability within each trait. The characters pod beak, pod constriction, pod reticulation and seed color enabled each of the accessions to be distinguished. These traits were also found to be discriminating in a study on groundnuts by Alleidi et al. (2016) in Burkina Faso. These traits could be key criteria for pod and seed structuring in groundnut. For seed color, this index gave a very low value (D = 0.21) compared with the other traits. It could therefore be said that the greatest variability in groundnut seeds is found in color. This high variability was confirmed by studies by Ghalmi (2011) in Algeria, Gbaguidi et al. (2015) in Benin and Djilé et al. (2016) in Cameroon. In this study, groundnut seed coloration showed 9 variants, whereas in the studies by Gbaguidi et al. (2015), Ghalmi (2011) and Djilé et al.

(2016), 8, 10 and 12 variants were observed respectively.

The variability of the accessions studied was also expressed in terms of quantitative characteristics, with germination times ranging from 7 to 8 days. Group III accessions had the lowest germination rate, while group I and II accessions had the highest. Higher seed germination depends on the availability of favorable environmental factors such as adequate temperature, light, salinity, humility and water (Cokkizgin, 2012), and the absence of seed-borne pathogens (Ahmed et al.,2017). In the case of flowering, the number of days to flowering of the accessions varies between 30 days and 34 days. Group I accession have a lower number of days to flowering (30 days). Accessions in group II had a higher number of days to flower (33 days), and accessions in group III had an average number of flowering days (32 days). Accessions with a number of days to maturity between 119 and 140 days belong to the early varieties, while those with a number of days between 140 and 143 days are the late varieties. This shows that group I with a small number of days to flowering has the shortest ripening time. These results are similar to those of Betdogo et al. (2015). In their study, they demonstrated that varieties with the shortest initiation times are the earliest to reach maturity. In this study, vegetative traits were used to differentiate groundnut accessions. Groups I and III were distinguished by their taller plants, while group II had the smallest plants among the groundnut accessions studied. The height of the accessions depends on their genotypes and above all on the particular soil and climatic conditions that enable them to develop their growth potential to the full. This great variability in plant height could be due to the genetic characteristics of the accessions. These results do not differ from those of (Makanur et al., 2013), who grouped cowpea genotypes according to their height into three classes: dwarf (less than or equal to 15 cm), medium (between 15 and 25 cm) and tall (25 cm). In this study, the late varieties gave better agronomic parameters than the early ones. This result is similar to those of Bonny and Djè (2011) who showed in their study that ecotypes with high vegetative and agronomic values are late and those with low morphological and production characteristics are said to be early. The names of the different accessions come from each cultural group and sub-group, which means that there is a high probability of obtaining duplicates of accessions that differ in name within each semantic group and sub-group. This conclusion is also put forward by Dansi et al. (2008) and Montcho et al. (2021). Furthermore, the dissemination of different groundnut accessions in Côte d'Ivoire, due to the free exchange of seeds between farmers, could explain this similarity between accessions. This has contributed to a loss of variability over the years. These results are identical to those obtained by (Banla et al., 2020) during a study on groundnut characterisation in Togo. The number of days to maturity was significantly and positively correlated with the weight of 100 dry seeds and dry seed yield. The correlation indicates that late-cycle accessions give high yields and early-cycle accessions give low yields. These results contradict those of Ouédraogo et al. (2008) who reported that in Burkina Faso, late accessions gave the lowest yields. This could be explained by the scarcity of rain in this semi-arid region of Burkina Faso. In this study, agronomic parameters were higher for long-cycle accessions, confirming the high-yield potential of late accessions.

Conclusion

The agromorphological characterisation of 57 groundnut accessions collected in Côte d'Ivoire showed diversity on the basis of qualitative and quantitative traits. The groundnut accessions were structured into three morphological groups on the basis of 16 quantitative characteristics. The study also made it possible to identify agromorphological traits that could contribute to improving groundnut yield. 16 promising accessions (PA1-4, PA1-11, PA1-13, PA1-16, PA8-1, PA12-1...PA16-2) were identified on the basis of their agromorphological performance. However, a biochemical study of the nutritional qualities of these accessions would complement these results with a view to their efficient use in varietal selection programmes and their dissemination. This study could make a significant contribution to improving the value of groundnut cultivation in Côte d'Ivoire.

COMPETING INTERESTS

The authors declare that they home no competing interests.

AUTHORS' CONTRIBUTIONS

BTAI and IJF conceived the experiments; BTAI and YB performed the experiments; BTAI and YB analysed the data; BTAI, YB and IJF wrote the manuscript and corrected it.

ACKNOWLEDGEMENTS

The authors would like to thank the people of the villages in the areas visited, who welcomed us with great kindness.

REFERENCES

Ahmed O, Olayika BN, Garuba T, Ahmed J, Etejere EO. 2017. Germination of several groundnut cultivars in relation to incidence of fungi. *Science World Journal*, **12**(1): 38-41. URL: www.scienceworldjournal.org

Alleidi I, Falalou H, Younoussa OM, Bakassou Y, Zongo JD. 2016. Caracterisation Agromorphological characterization of groundnut (*Arachis hypogaea* L.) accessions for oil content. *European Scientific Journal*, **12**(15): 337-351. DOI: http://dx.doi.org/10.19044/esj.2016.v12n15p337

Banla EM, Dzidzienyo DK, Diangar MM, Melomey LD, Offei SK, Tongoona P, Desmae H. 2020. Molecular and phenotypic diversity of groundnut (*Arachis hypogaea* L) cultivars in Togo. *Physiology and Molecular Biology of Plants*, **6**(7): 1489–1504. DOI: https://doi.org/10.1007/s12298-020-00837-8

Baudouin L, Santos G. 2005. Morphometric methods of determining diversity in coconuts. In *Coconut Genetic Resources*, Batugal P, Ramanatha V, Olivier J (Eds). IPGRI-APO, Serdang, Malaysia, pp. 209–223. URL :https://genebanks.cgiar.org/wp-content/uploads/2017/01/Coconut_genetic_resources.pdf

Betdogo S, Bourou S, Adamou I. 2015. Agronomic evaluation of five peanut cultivars (*Arachis hypogeae* L) introduced in the North Cameroon region. *Journal of Applied Biosciences*, **89**:8311-8319. URL:http://www.ajol.info/index.php/jab/article/view/119383/108846

Boko-Koiadia ANN, Guéladio C, Brama K, Dedy S. 2016. Climate variability and environmental change in korhogo, Ivory Coast Myth or reality. *European Scientific Journal*, ESJ, **12**(5) : 158. DOI : https://dpoi.org/10.19044/esj.2016.v12n5p158

Bonny BS, Djè Y. 2011. Morphological and agronomic variability of traditional voandzou varieties [*Vigna subterranea* (L.) Verdc. (Fabaceae)] from Ivory Coast. *Journal of Applied Bioscience,* **41**: 2820 – 2835. URL: http://www.m.elewa.org/JABS/2011/41/9.pdf

Christie ME, Kyamureku P, Kaaya A, Devenport A. 2014. Farmers, peanuts, and aflatoxins in Uganda: A gendered approach. *Development in Practice*, **25**(1): 4–18. DOI: https://doi.org/10.1080/09614524.2015.983459

Cokkizgin A. 2012. Salinty stress in common Bean (*Phaseolus vulgaris* L.) seed germination. *Notulae Botanicae Horti Agrobotanici Cluj-Napoca*, **40**(1): 177-182. DOI: https://doi.org/10.15835/nbha4017493

Dansi A, Adjatin A, Adoukonou-Sagbadja H, Faladé V, Yedomonhan H, Odou D, Dossou B. 2008. Traditional leafy vegetables and their use in the Benin Republic. *Genetic Resources and Crop Evolution*, **55**: 1239-1256. DOI: https://doi.org/10.1007/s10722-008-9324-z

Bouba D, Boukar O, Kosma P, Miafo APT, Madi A. 2016. Agrogenetic diversity of local cultivars of cowpea (*vigna unguiculata*) in the far-north region of cameroon. *International Journal of Innovation and Applied Studies*, **17**(1): 255. URL: http://www.ijias.issr-journals.org/

FAOSTAT. 2020. Available at: <*http://faostat.fao.org/faostat*> (consult 08/08/2023)

Gbaguidi AA, Assogba P, Dansi M, Yedomonhan H, Dansi A. 2015. Agromorphological characterization of cowpea varieties grown in Benin. *International Journal of Biological and Chemical Sciences*, **9**(2): 1050-1066. DOI: http://dx.doi.org/10.4314/ijbcs.v9i2.40

Ghalmi N. 2011. Study of the genetic diversity of some local ecotypes of *Vigna unguiculata* (L.) Walp cultivated in Algeria. National Higher Agronomic School (ENSEA). El harach-Algiers. Doctoral thesis in agricultural sciences. Algiers, Algeria, p.177.

Guchi E, Ayalew A, Dejene M, Ketema M, Asalf B, Fininsa C. 2014. Occurrence of Aspergillus Species in Groundnut (*Arachis hypogaea* L.) along the Value Chain in Different Agro-Ecological Zones of Eastern Ethiopia. *Journal Applied Environmental Microbiology,* **2**: 309-317. DOI: 10.12691/jaem-2-6-

ICRISAT. 1992. *Descriptor for Peanut* (*Arachis hypogaea* L.). ICRISAT; 51p.

Koné FR. 2017. *The Malinké in Ivory Coast.* African societal Analysis (ASA), the ASSN think tank.: National Institute of Statistics (INS), RGPH 2014, 8 p.

Ndoye M, Gueye M, Faye I, Diatta J, Niang NA, Dieng MB, Ndiaye S. 2024. Cartographie des déterminants de la qualité des semences d'arachide (*Arachis hypogeae* L.) produites dans les principales zones agricoles au Sénégal. *Int. J. Biol. Chem. Sci.*, **18**(1): 69–81. DOI : https://dx.doi.org/10.4314/ijbcs.v18i1.6

Noba K, Ngom A, Guèye M, Bassène C, Kane M, Diop I, Ba AT. 2014. Groundnut in Senegal: current state, benefits and constraints of relaunch of the sector. *Oilseeds and Fats, Crops and Lipids*, **21**(5): 205. DOI: https://doi.org/10.1051/ocl/2013039

Makanur B, Deshpande VK, Vyakaranahal BS. 2013. Characterization of cowpea genotypes based on quantitative descriptors. *Academic Journals,* **8**(4): 1183-1188. URL: https://thebioscan.com/index.php/pub/article/view/260

Maliki R, Belloa S, N'Djolossèa K, Hinnoua LC, Houénoub C, Dagbénonbakinc GD. 2020. Agronomic performance of improved groundnut varieties introduced from Mali under the ecological conditions of central Benin. *Journal of Animal & Plant Sciences,* **46**(3): 8271-8287. DOI: https://doi.org/10.35759/JAnmPlSci.v46-3

Montcho D, Gbénou P, Missihoun AA, Assogba F, Hodehou DA, Gandonou C, Agbangla C. 2021. Morphological diversities and associated preference traits in Peanut (*Arachis hypogaea* L.) landraces from central and southern Benin. *International Journal of Biological and Chemical Sciences*, **15**(3): 1050-1061. DOI: 10.4314/ijbcs.v15i3.16

Ouedraogo M, Ouedraogo JT, Tignere JB, Balma D, Dabire CB, Konaté G. 2008. Characterization and Evaluation of accessions of Bambara groundnut [*Vigna subterranea* (L.) Verdcourt] from Burkina Faso. *Journal Science and Nature*, **5**(2): 191-197. DOI: 10.4314/scinat.v5i2.42164

StatSoft, Inc. 2005. STATISTICA (version 7.1) [Software]. StatSoft, France.

Yao SDM, Koffi EBZ, Daramcoum WAMP, Yoboue K, Konan JLK, Diarrassouba N. 2020. Contribution of qualitative descriptors in the identification of Grand coconut accessions for field collection regeneration programs. *Int. J. Biol. Chem. Sci.*, **14**(2): 580-599. DOI: 10.4314/ijbcs.v14i2.22