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DIVERSITY OF COFFEE GENOTYPES BASED ON SOME PHENOTYPIC TRAITS

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ABSTRACT

Understanding the variability that exists in a crop species is key to improvement procedures. Four cross compatible coffee (Coffea canephora) genotypes were grown in a randomized complete block design with four replications at Cocoa Research Institute, Ibadan (7^0 13'N, 3^0 51'E), Nigeria and evaluated using nine quantitative traits from their seedlings. Analysis of variance (ANOVA) results showed significantly differences among the genotypes for height, leaf length and leaf width. Range of performance of the genotypes were height (5.5cm – 12.85cm), leaf number (3.75 – 5.500), stem diameter (2.35mm – 2.57mm), root number (108.00 – 211.00), root length (11.18cm – 15.48cm), root weight (0.63g – 1.88g), shoot weight (1.75g – 2.63g), leaf length (7.68cm–10.53cm), leaf width (3.19mm-4.65mm). Positive and significant ($P \leq 0.05$) correlation existed between root weight and root number, shoot weight and stem diameter; shoot weight and leaf width. The mean Gower genetic distance among the four genotypes was 0.4521; the least (0.27794) existed between C36 and M10 while the highest (0.70491) was between C111 and T1049. The first three principal component axes explained 100% of the variation.

KEY WORDS: *Coffee, Genotypes, Diversity, Phenotypic traits*

INTRODUCTION

Coffee, the source of beverage used in manufacture of instant and decaffeinated coffee originated from tropical Africa where wild populations occur abundantly in the tropical regions [1]. The genus *Coffea* belongs to Rubiaceace family which consists of about 640 genera varied in their forms from tiny herbs to tall trees [2]. Flowering and flowering characteristics distinguished *Coffea* from its closely related genus, *Psilanthus* and consists of about 105 taxa [3]. The genus *Coffea* L was further divided into two sub genera *Coffea* and *Paracoffea* and was native to Madagascar and inter-tropical forest of Africa while the genus *Psilanthus* originates from either Asia or Africa [4]. Deliberate attention has been given to the sub-genus *Coffea* especially *Coffea arabica* L. and *Coffea canephora* Pierre which are of economic importance [3]. In the genus, only arabica species is a tetraploid with 2n = 4X = 44 chromosome and self-fertile while others are diploid (2n = 2X =22) and generally self- incompatible [5]. Majority of the species occur naturally in Africa, Madagascar and the Mascarenes, predominantly restricted to the humid evergreen forest while other species are found in seasonally dry deciduous forest and/or bush land [6].

Periodic quantification and evaluation of the diversity status of a germplasm is a necessary exercise. The essence is to update the breeders on the genetic resources of the germplasm and form a basis for further and timely breeding program [7]. Diversity is the basis for genetic improvement. Information regarding the variability among available germplasm is vital to devise efficient plant breeding programmes as well as to maintain genetic diversity in a given gene pool. Genetic diversity can be estimated using morphological traits as well as biochemical and DNA-based markers [8]. As new coffee varieties are continuously being developed through hybridization, there is need to determine the level and sources of morphological variation within and between new and existing coffee varieties. Genetic consistency within varieties is essential to quality assurance for any agricultural product.

The objective of this study was to understand the pattern of diversity among the four cross compatible out of five cross compatible genotypes (as identified by Omolaja S.S. in his PhD thesis) within *Coffea canephora* of Nigeria coffee germplasm for guided selection for further improvement, since the existing genetic base is perceived to be narrow.

MATERIALS AND METHODS

Four genotypes of *C canephora* (C36, C111, M10 and T1049) were selected from five cross compatible genotypes of coffee and raised from half node stem cuttings for six months in the nursery. The genotypes were experimentally laid out in randomized complete block design (RCBD) with four replications at Cocoa Research Institute of Nigeria (CRIN), Ibadan (7^0 13'N, 3^0 51'E). At the end of six months, the experiment was terminated after which data collection on nine agronomic traits. These traits include: height (cm), leaf number, stem diameter (mm), leaf length (cm), leaf width (mm), root number, root length (cm), root weight (grammes), and shoot weight (grammes). Data were analyzed using statistical analysis system SAS V.9.2 [9]. The data of the nine parameters were subjected to analysis of variance (ANOVA), using PROC GLM in SAS. The means were separated using Duncan Multiple Range Test (DMRT). The interrelationship among the eight parameters was verified using the Pearson correlation coefficient method in SAS Analyst of SAS version, 9.2. The data matrix of the four genotypes and nine parameters were subjected to Gower Genetic Distance [10] analysis in SAS. The resulting product was further subjected to Principal Component Analysis (PCA) and a tri-dimensional figure was plotted from the first three axes values of the PCA.

RESULTS

Table1: Mean squares of characters of the 4 coffee genotypes used in the study

SOV	DF	Mean Square								
		HT	NL	SD	NR	RL	RW	SW	LL	LW
Genotypes	3	38.59**	3.56	0.04	7572.06	14.39	1.31	0.60	6.35***	1.74**
Error	9	4.33	1.56	0.43	8231.12	6.99	0.67	0.59	0.47	0.23
Mean	-	8.83	4.56	2.49	150.94	12.81	1.03	2.31	9.16	4.09
CV (%)	-	23.58	27.40	26.26	60.11	20.65	79.28	33.22	7.49	11.78

NB: SOV- Source of Variation, DF – Degree of Freedom, HT – Height, NL – Leaf Number, SD – Stem Diameter, NR – Root Number, RL – Root Length, RN – Root Weight, SW – Shoot Weight, LL –Leaf Length, and LW – Leaf Width.

**-$P \leq 0.01$; ** - $P \leq 0.001$

Table1 revealed that the height, the leaf length and the leaf width were the only traits which shows significant ($P \leq 0.01$ and $P \leq 0.001$) differences among the four genotypes. The mean height for the four genotypes was 8.83cm, the mean leaf length was 9.16, and the mean leaf width was 4.09. The coefficient of variation ranged between 7.49 (Leaf length) to 79.28 (RW).

Table 2: Mean performance of the 4 coffee genotypes used in the study

Clone	Mean								
	HT	NL	SD	NR	RL	RW	SW	LL	LW
M10	12.85a	3.75a	2.57a	211.00a	12.78ab	1.88a	2.63a	10.53a	4.51a
T1049	9.33b	5.50a	2.50a	136.00a	11.80ab	0.75a	2.50a	9.81a	4.66a
C111	7.63bc	5.25a	2.55a	108.00a	15.48a	0.63a	2.38a	8.63b	4.03a
C36	5.50c	3.75a	2.35a	148.75a	11.18b	0.88a	1.75a	7.68b	3.19b

Note: Means with the same letters along the column are not significantly different using DMRT at 0.05 level of probability.
HT – Height, NL – Leaf Number, SD – Stem Diameter, NR – Root Number, RL – Root Length, RN – Root Weight SW – Shoot Weight, LL –Leaf Length, and LW – Leaf Width.

From Table 2, the mean values of the four genotypes for the nine parameters, M10 had the tallest tall plants and the longest leaves. C111 had the longest roots. Range of performance of the genotypes were height (5.5 – 12.85), leaf number (3.75 – 5.500), stem diameter (2.350 – 2.57), root number (108.00 – 211.00), root length (11.18 – 15.48), root weight (0.63 – 1.88), shoot weight (1.75 – 2.63), leaf length (7.68–10.53), leaf width (3.19-4.65).

Table 3: Pearson correlation coefficient of nine phenotypic traits.

	HT	NL	SD	NR	RL	RW	SW	LL
NL	-0.1052							
SD	0.7863	0.3617						
NR	0,7229	-0.7351	0.1887					
RL	0.0901	0.4175	0.6461	-0.3952				
RW	0.8001	-0.6806	0.3656	0.9738*	-0.1760			
S W	0.8689	0.3834	0.9523*	0.2862	0.4005	0.4102		
LL	0.9695	0.0928	0.7871	0.5998	0.0392	0.6567	0.9168	
LW	0.8188	0.4679	0.8338	0.2498	0.1886	0.3196	0.9594*	0.9233

NB: HT – Height, NL – Leaf Number, SD – Stem Diameter, NR – Root Number, RL – Root Length, RN – Root Weight SW – Shoot Weight, LL –Leaf Length, and LW – Leaf Width.

*-P≤0.05

Table 3 shows the relationship between the nine phenotypic traits. The shoot weight exhibited significant (P≤0.05) and positive correlation with stem diameter (r =0.952) and leaf width (r =0.959). Positive and significant (P≤0.05) correlation existed between root weight and root number (r = 0.974).

Table 4: Eigenvalues and factor scores of major characters associated with the first four principal component axes used in ordination of 4 coffee genotypes

	Prin1	Prin2	Prin3
HT	**0.429759**	-.105165	-.001504
NL	0.028122	**0.553783**	**-.351623**
SD	**0.382049**	0.241897	0.275870
NR	0.256664	**-.474699**	0.033769
RL	0.093918	**0.394778**	**0.764599**
RW	0.299908	**-.409482**	0.221632
SW	**0.412046**	0.193874	-.037078
LL	**0.427246**	-.022882	-.220875
LW	**0.389348**	0.191770	**-.339443**
Eigenvalue	5.2406	2.9013	**0.8580**
Differences	2.3393	2.0433	**0.8580**
Proportion	0.5823	0.3224	0.0953
Cumulative	0.5823	0.9047	1.0000

Note: Factor score of 0.30 and above was considered significant in the determination of variation

From Table 4, the total genetic variation among the four genotypes was accounted for by the first three Principal Component (PC) axes, with variance proportion ranging from 58.23% (PC1) to 9.53% (PC3). The eigen values for each axes followed the descending trend as the variance proportions. The first three PC axes accounted for 100% of total genetic variation among the four genotypes. By the magnitude of eigenvector loading, plant height (0.429), stem diameter (0.382), shoot weight (0.412), leaf length (0.427), and leaf width (0.389) were majorly loaded on PC1. Leaf number and root length had the highest eigen values loading in PC2 and PC3 respectively. The nine phenotypic traits were very valuable in describing and distinguishing the four genotypes.

Table 5: Gower genetic distance among the four genotypes

	M10	C111	T1049
C111	0.3793		
T1049	0.5414	0.6903	
C36	0.2582	0.4164	0.4227

Table 5 presents the different genetic distance among the four coffee3 genotypes. The highest distance (0.69) was between T1029and C111, while the least (0.25) was between C36 and M10.

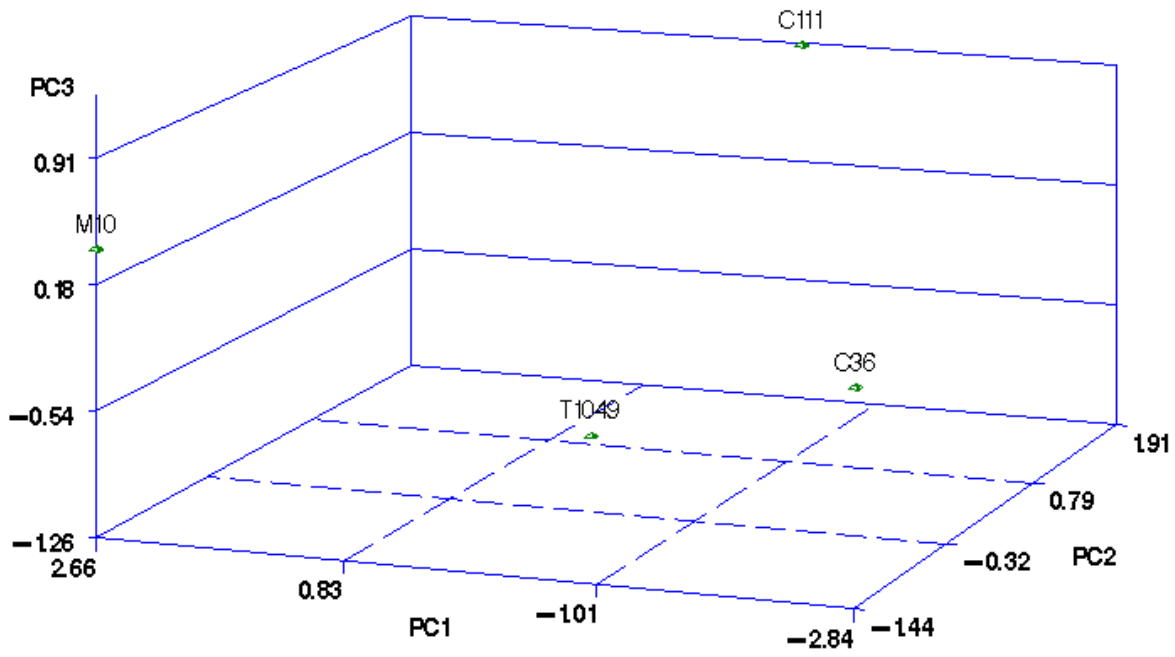

Figure 1: The tri-dimensional display of the four coffee genotypes

Figure1 presents that the four genotypes are widely dispersed. C36 and M10 are the closest genotypes. However, C111 and T1049 were mostly diverse. C36 was equally a nearer neighbor to C111 and M10.

DISCUSSION

The significant variation in the analysis of variance among the genotypes for plant height, leaf length and shoot weight indicated that these traits significantly distinguished among them. The relatively high coefficients of variation among the traits that describe the genotypes may be because a relatively few number of genotypes were involved in the study. It may also be due to rounding-off errors. The result of the correlation analysis obviously presents leaf area, and stem diameter as good determinants of shoot weight. It also showed that more number of roots translated into higher root

weight given the plant firm establishment and anchoring in the soil. Plant height, stem diameter, shoot weight, leaf length and leaf width were most significant in discriminating among the genotypes, having being loaded majorly on the first Principal Component axis, the most important axis.

There was a significant morphological variation within the genotypes. Since the higher the genetic distance the smaller the similarity, it can be inferred that, morphologically, there is wider dissimilarity between quillo and java cultivars of *C. canephora*. This is in agreement with Kumal et al. [3] that coffee trees differ greatly in morphology. The results concurs with those of Anthony *et al.* [11], who also demonstrated low genetic variation within Arabica coffee genotypes. Masumbuko and Bryngelsson [12] also found similar results when comparing diploid coffee species and cultivated *Coffea arabica* L. from Tanzania.

CONCLUSION

The study demonstrated notable morphological variation among the cultivars that were tested indicating significant genetic variation. There is however the need to widen the genetic base of coffee genotypes so as to create the required variabilities for further improvement of the crop.

REFERENCCES

1. *Berthaud, J. and A. Charrier, 1988. Genetic resources of Coffea. In: R.J. Clarke and R. Macrae (Eds.), Coffee: Agronomy, vol. IV, pp. 1-41. Elsevier Applied Science, London.*
2. *Bremer, B.,1996.Combined and separate analyses of morphological and molecular data in the plant family Rubiace Cladistics, 12:21-40..*
3. *Kumar, S.A., J. Sudisha and H.L. Screenath, 2008. Genetic relation of Coffea and Indian Psilanthus species as revealed through RAPD and ISSR markers. IJBI, 3: 2-2.*
4. *Bridson, D., 1987. Nomenclatural notes on Psilanthus, including Coffea sect. Paracoffea (Rubiaceae tribe Coffeeae). Kew Bull., 42: 453-460.*
5. *Clarindo, W.R. and Carvalho, C.R. 2008. "First Coffea arabica karyogram showing that this species is a true allotetraploid," Plant Systematics and Evolution, vol. 274, no. 3-4, pp. 237–241.*
6. *Maurin, O., Davis, A. P., Chester, M., Mvungi, E.F., Jaufeerally- Fakim, Y. and M. F. Fay 2007. Towards a phylogeny for Coffea (Rubiaceae): Identifying Well supported Lineages based on Nuclear and Plastid DNA sequences. Annals ofBotany **100**, 1565-1583.*
7. *Hue, T.T.M., 2005. Genetic variation in cultivated coffee (Coffea arabica L.) Accessions in Northern New South Wales, Australia. Masters Thesis, Southern Cross University, Australia.*
8. *Masumbuko, L.I., T. Bryngelsson, E.E. Mneney and B. Salomon, 2003. Genetic diversity in Tanzanian Arabica coffee using random amplified polymorphic DNA (RAPD) markers. Hereditas, 139: 56-63.*
9. *SAS Institute. 2007. The SAS system for Windows. Release 9.2. SAS. Inst., Gary, NC, USA.*
10. *Gower, J.C. 1971. A general coefficient of similarity and some of its properties. Biomet. 27:623–637.*
11. *Anthony, F., B. Bertrand, O. Quiros, A. Wilches, P. Lashermes, J. Berthaud and A. Charrier, 2001. Genetic diversity of wild coffee (Coffea arabica L.) using molecular markers. Euphytica,118:53-65.*
12. *Masumbuko, L.I. and T. Bryngelsson, 2006. Inter simple sequence repeat (ISSR) analysis of diploid coffee species and cultivated Coffea arabica L. from Tanzania. Genet. Resourc. Crop Evolut., 53: 357-366.*