

Genetic variability in morpho-agronomic traits of various accessions of *Vigna subterranea* (L.) Verdc.

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Abstract: *Vigna subterranea* is an indigenous African legume widely cultivated across the continent. It is a highly diverse crop exhibiting diversity in morpho-agronomic characteristics. This genetic diversity is also crucial for crop improvement as it determines which breeding strategy/ methodology to utilize in its improvement. The study evaluated the diversity in morpho-agronomic characteristics of different accessions of Bambara groundnut. 'TVSu596' exhibited the highest germination percentage (100 %) and shortest days to 50 % flowering (40 days) while 'TVSu11' had the highest number of leaves (146). Qualitative evaluation revealed the diversity existing in their morphological characteristics. Elemental analysis showed the accessions are rich in mineral elements and exhibit diversity. Principal component analysis revealed 83.37 % of total variations in morphological and yield traits by the first three principal axes. Traits such as number of leaves, petiole length, and days to 50 % flowering furnish most of the variations. Cluster analysis revealed the accessions clustered into 4 groups. These accessions are therefore recommended for utilization in development of improved cultivars or early-maturing varieties

Key words: *Vigna subterranea*; Bambara groundnut; genetic variation; morpho-agronomic analysis; chemical analysis

Genetska raznolikost in morfološko-agronomske lastnosti različnih akcesij bambare (*Vigna subterranea* (L.) Verdc.)

Izvleček: Bambara (*Vigna subterranea*) je samonikla afriška stročnica, ki se na veliko goji širom kontinenta. Je zelo raznolika poljščina z zelo različnimi morfološko-agronomskimi lastnostmi. Ta genetska raznolikost je najpomembnejša za njeno izboljšanje in določa tudi žlahtniteljske strategije in metode, ki jih je potrebno pri tem uporabiti. V raziskavi je bila ovrednotena raznolikost morfološko agronomskih lastnosti različnih akcesij bambare. Akcesija TVSu596 je pokazala največji odstotek kalivosti (100 %) in najkrajše obdobje do 50 % cvetenja (40 dni), akcesija TVSu11 je imela največje število listov (146). Kakovostno ovrednotenje je odkrilo, da obstajajo razlike v morfološko-agronomskih lastnostih. Snovna analiza je pokazala, da so akcesije bogate na mineralih in da so razlike v vsebnostih le teh velike. Analiza glavnih komponent je odkrila, da je 83,37 % celotne variabilnosti v morfoloških lastnostih in je pojasnjeno s prvimi tremi osnovnimi osmi. Lastnosti kot so število listov, dolžina peclja in število dni do 50 % cvetenja prispevajo največji delež variabilnosti. Analiza združevanja je odkrila, da so akcesije porazdeljene v 4 skupine, ki jih priporočamo za uporabo pri vzgoji izboljšanih sort ali za zgodnje dozorevanje.

Gljučne besede: *Vigna subterranea*; bambara; genetska raznolikost; analiza morfološko-agronomskih lastnosti; kemijska analiza

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1 INTRODUCTION

Vigna subterranea (L.) Verdc. popularly known as bambara groundnut is an indigenous African legume crop which is widely cultivated across the continent (Mkandawire, 2007). The seeds are used during the performance of funeral rites. It also possess medicinal properties, being chiefly used in the control of diarrhoea, skin rashes, and swollen jaw disease (Akpalu et al., 2013). *V. subterranea* is a highly diverse crop in terms of its size of seeds, colour of seeds, plant height, eye colour, eye patterns, hilum colour and patterns, and other morpho-agronomic characteristics (Ouedraogo et al., 2008; Akpalu et al., 2013). This genetic diversity is the basis for adaptation and survival of the species and makes it easy for them to adapt to changing of environmental conditions (Rao et al., 2002; Sevik et al., 2010). Adequate information about genetic diversity within crop species is essential for crop improvement as it determines methodologies to utilize in the improvement of the species (Aliyu et al., 2016). Hence, estimation of genetic variability of different traits is not only of economic importance but also crucial in cultivar development and improvement of any plant species (Odongo et al., 2015). This study therefore comparatively assessed the genetic variability in the morpho-agronomic traits and mineral elements present in seeds of seven colour variants of *V. subterranea*.

2 MATERIALS AND METHODS

The study was carried out within Federal College of Forestry, Ibadan, Nigeria. Seeds of seven accessions of *V. subterranea* (TVSu 119, TVSu 596, TVSu 182, TVSu 11, TVSu 367, TVSu 49 and TVSu 254) were utilized in the study. Germination test was conducted in a laboratory and the seedlings were later transplanted into modified plastic buckets arranged in a randomized complete block design (RCBD) with three replications. For the mineral elements determination, seeds of each accession were ground and 1 g of each was dry ashed for 5 h

in a muffle furnace at 550 °C until a white residue with constant mass was obtained. The ash was digested with 3M HCl and some of the mineral elements were investigated using atomic absorption spectrophotometer (AAS) (AOAC, 2003). For the evaluation of quantitative data, the analysis of variance (ANOVA), PCA and correlations were used.

3 RESULTS AND DISCUSSION

The result of elemental analysis is presented in Table 1. The result showed that ‘TVSu119’ is a good source of mineral elements though it is a little deficient in copper content, followed by ‘TVSu596’ which is rich in magnesium and potassium. This result is similar to that observed by Amarteifio et al. (2006).

Qualitative characteristics assessment result showed that two types of petiole pigmentation pattern (non-pigmented and slightly-pigmented) were observed. Leaf colour assessment result also showed the presence of three different types (dark green, pale green and green) of pigmentation patterns. The result of quantitative characters studied on the seven accessions is presented in Table 2. Result showed that significant difference ($p \leq 0.01$) exists in all characters among all the accessions studied. NL ranged from 67.80 to 146.00. This contrasts with the result of Shegro et al. (2013). TLL ranged from 5.65 cm to 8.16 cm in ‘TVSu49’. This is similar to the result of Shegro et al. (2013) but contrasted with the result of Ndiang et al. (2014).

TLW ranged from 2.38 cm to 4.72 cm in ‘TVSu49’. This is similar to the result of Shegro et al. (2013). Petiole length ranges from 15.13 cm to 26.55 cm in ‘TVSu49’. This contrasts with the result of Shegro et al. (2013) and Ndiang et al. (2014). DFF ranged from 40 days to 49 days. This is similar to the result of Brink et al. (2006) but contrasted with the result of Ouedraogo et al. (2008). D5F ranged from 40 days to 43 days. This is similar to the result of Brink et al. (2006). Number of seeds/plant ranged from 3.0 to 6.0. The low seed yield observed in these ac-

Table 1: Selected mineral elements studied on the analysed accessions of *V. subterranea*

Varieties	Accessions	Ca (%)	Mg (%)	K (%)	Fe (mg g ⁻¹)	Cu (mg g ⁻¹)
1	TVSu119	0.03	0.24	1.61	40.92	7.49
2	TVSu596	0.01	0.25	1.70	31.97	8.49
3	TVSu182	0.02	0.21	1.46	20.93	7.48
4	TVSu11	0.02	0.21	1.56	20.45	9.48
5	TVSu367	0.03	0.23	1.31	25.97	8.99
6	TVSu49	0.02	0.21	1.42	36.99	9.50
7	TVSu254	0.03	0.23	1.53	30.94	19.96

Table 2: Quantitative characters studied on the analysed accessions of *V. subterranea*

Accessions	GP	HL	SR	LN	NL	TLL	TLW	PL	DFF	D5F
TVSu119	56 ^e	2.25 ^{bc}	3.20 ^b	9.70 ^b	67.80 ^d	6.28 ^c	2.38 ^c	17.30 ^{bc}	49 ^a	51 ^a
TVSu596	100 ^a	4.26 ^a	8.96 ^a	17.92 ^a	92.20 ^c	5.65 ^c	2.50 ^c	15.13 ^d	40 ^d	40 ^f
TVSu182	84 ^b	2.92 ^{bc}	8.17 ^a	13.65 ^{ab}	126.90 ^{ab}	6.12 ^c	3.08 ^b	18.73 ^{bc}	45 ^b	49 ^b
TVSu11	60 ^d	2.84 ^b	4.23 ^b	13.07 ^{ab}	146.00 ^a	5.80 ^c	2.86 ^b	19.33 ^b	40 ^d	43 ^c
TVSu367	56 ^e	2.44 ^b	3.95 ^b	5.78 ^b	106.10 ^{bc}	6.77 ^b	3.01 ^b	17.05 ^{cd}	41 ^d	44 ^e
TVSu49	79 ^c	2.24 ^{bc}	4.31 ^b	8.08 ^b	85.50 ^{cd}	8.16 ^a	4.72 ^a	26.55 ^a	40 ^d	46 ^c
TVSu254	80 ^c	1.17 ^c	4.47 ^b	8.52 ^b	122.10 ^b	8.07 ^a	2.98 ^b	19.18 ^b	43 ^c	45 ^{cd}
Mean	73.57	2.50	5.33	10.96	107.66	6.69	3.08	19.04	42.57	45.43
CV (%)	1.26	30.61	38.54	49.05	21.05	9.54	8.86	11.09	2.35	2.20
S.E.M ±	0.53	0.34	0.92	2.40	7.17	0.20	8.62	0.67	0.58	0.58
F Test	*	*	*	*	*	*	*	*	*	*
L.S.D (0.05)	1.62	0.99	2.66	6.96	20.25	0.57	0.24	1.89	1.75	1.75

NOTE: GP-Germination percentage; HL-Hypocotyl length; SR-Seminal root length; LN-Lateral root number; NL-Number of leaves; TLL-Terminal leaflet length; TLW- Terminal leaflet width; PL-Petiole length; DFF-Days to first flowering; D5F-Days to 50 % flowering. Means with the same letters are not significantly different from each other. *: Significant at 5 % level of probability. **: Significant at 1 % level of probability.

Table 3: Correlations for morphological and yield characteristics of the analysed accessions of *V. subterranea*

	GP	HL	SR	LN	NL	TLL	TLW	PL	DFF	D5F
GP	1									
HL	0.45**	1								
SR	0.84**	0.73**	1							
LN	0.64**	0.81**	0.81**	1						
NL	-0.01	-0.06	0.15	0.17	1					
TLL	0.01	-0.77**	-0.45**	-0.71**	-0.15	1				
TLW	0.12	-0.28	-0.18	-0.40**	-0.07	0.70**	1			
PL	-0.01	-0.42**	-0.34*	-0.41**	-0.04	0.70**	0.94**	1		
DFF	-0.30*	-0.30*	-0.19	-0.12	-0.37*	-0.11	-0.42**	-0.25	1	
D5F	-0.39*	-0.47**	-0.34*	-0.37*	-0.30*	0.16	0.05	0.21	0.86**	1

* Correlation is significant at the 0.05 level; **Correlation is significant at the 0.01 level.

cessions is similar to the result of Linnemann (1995). The co-efficient of variation (CV) ranged from 1.26 % to 49.05 %. This showed that a high level of genetic diversity, exploitable by plant breeders, existed in the studied traits. Standard error of mean (SEM) ranges from 0.20 to 0.92 showing that the data is normally distributed with a steep bell-shaped curve. Pearson's correlation analysis (Table 3) showed that petiole length was strongly and positively correlated with TLW and TLL but negatively correlated with HL, LN and DFF. Positive correlation of germination percentage with SR, LN and HL indicated that accessions with higher germination percentage exhibited increased vegetative growth characteristics. While negative correlation with DFF and D5F indicated that accessions

with higher germination percentage possessed lower days to first and 50 % flowering.

The results of the PCA analysis are presented in Table 4. The first five principal components explained about 98.2 % of the total variation. The Eigen values ranged from 4.33 to 0.64. Principal components axes 1 and 2 accounted for 43.33 % and 25.84 % variation respectively.

4 CONCLUSION

From the investigation, this study therefore submits that the germplasm displayed high genetic variability for the characteristics studied; hence they can still be im-

Table 4: The Eigenvalues, proportion of variability and the phenotypic traits contributing to the first five Principal components of *V. subterranea*

Item	PC1	PC2	PC3	PC4	PC5
Eigenvalues	4.33	2.58	1.42	0.84	0.64
%Variance per PC axes	0.43	0.26	0.14	0.08	0.06
Cumulative Variance	0.43	0.69	0.83	0.92	0.98
Morphological traits	Eigenvectors				
Terminal leaflet length (cm)	0.38	0.29	-	-	-
Petiole length (cm)	0.31	0.38	0.20	-	-
Days to 50 % flowering	0.26	-0.35	0.39	0.33	0.31
Terminal leaflet width (cm)	0.26	0.47	0.21	-	0.34
Days to first flowering	-	-0.52	0.36	0.25	-
Lateral root number	-0.44	-	-	-	-
Hypocotyl length (cm)	-0.42	-	-	-0.33	0.39
Seminal root length (cm)	-0.40	-	0.30	0.27	-
Germination %	-0.27	0.33	0.43	0.21	-0.40
Number of leaves	-	-	-0.55	0.74	-

NB: Only eigenvectors with values ≥ 0.20 are presented.

proved genetically, as they can be useful to plant breeders who may be interested in specific traits and their variation within the species. The earliness in days to first and 50 % flowering displayed by TVSu596 meant it could be utilized in the development of early-maturing varieties or cultivars. The study thus recommends further studies on the nutritional value of these accessions in order to evaluate their protein, carbohydrate and fat contents.

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