Preliminary screening of agro-morphological variations among and within Bambara groundnut [*Vigna subterranean* (L.)] landraces in Northern KwaZulu-Natal

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Background

Bambara groundnut [Vigna subterranean (L.)] is an important underutilized, drought tolerant, annual leguminous crop widely cultivated in Africa for its nutritious edible seeds. Despite its nutritional value, Bambara remains at a subsistence level by small scale famers who use landraces. Bambara landraces have a diverse seed variety that may offer a wide genetic diversity, however still needing both morphological and genetic characterisation.

Significance
- Income generation
- Nutritional security
- Diet diversification
- Intercropping
- Animal feed

Strengths
- Tolerance of poor quality soils
- Grows well in semi-arid & tropical helps
- Nitrogen fixing

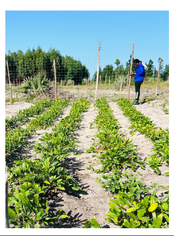
Research gaps
- Lack of commercial varieties
- Limited research on its drought tolerance and nutritional composition

Aim and Objectives

- Research project aims at assessing the genetic diversity and evaluating the nutritional composition of drought tolerant Bambara landraces in South Africa
- Estimate morphological variations within and among Bambara landraces for drought tolerance by assessing twenty-four leaf morphology, pods and seeds related traits.
- Evaluate relationships between traits and among landraces through principal components analysis and correlation analysis.
- Identify and select the best performing landraces under rain-fed condition in Hluhluwe through K means clustering analysis.

Materials and methods

- Four characterised landraces purchased from local market, were planted in Northern KwaZulu-Natal(Hluhluwe and Manguza) under rain-fed conditions.
- Experimental design: non-replicated row column design.
- A total of thirteen quantitative traits and six qualitative traits were recorded according to Bambara groundnut descriptors note.



Results

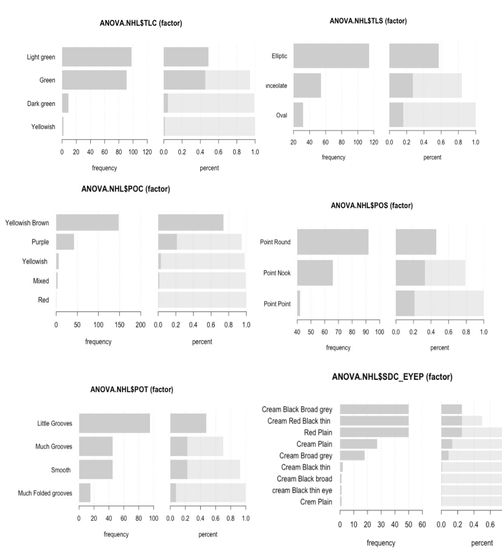


Figure 1.: Distribution of leaf colour, leaf shape and pod colour, shape texture and seed coat colour and eye pattern among Bambara groundnut landraces in Hluhluwe.

Figure 2: a) Bambara groundnut assorted by pod shape(shape point-round, point-nook and point-point), b) pod texture (smooth, little grooves, much grooves and much folded

Figure 3: description of presence and absence of eye and its pattern(cream with black speckles, cream with plain eye, cream with black-butterfly eye, Cream with red-butterfly eye, cream with black thin eye and red with plain eye

Table 1: Summary statistics of agronomic and yield related traits among Bambara landraces in Hluhluwe

SOV	DF	G(%)	NSP	NLP	TLW	TLL	CHL	BMS	NPP	POWT	POL	POW	SDL	SDW	GY
LANDRACE	3	7099***	13029***	117264***	0.62**	1.77 ***	401.6 ***	0.17***	1935.9 ***	117264***	79.74***	24.44***	269.0***	418.4***	0.62**
PLOT	19	3974***	456	4108	0.021	0.054	369.0 **	0.003	0.4	4108	1.71	8.40	0.2	31.2	0.02
LANDRACE :PLOT	23	1298***	1919**	17275**	0.20	0.54	229.9 *	0.042 *	109.4	17275**	40.55**	8.15*	371.9***	376.7***	0.20
RESIDUAL ERROR	194	70	433	3898	0.14	0.56	47.6	0.017	80	376.7	9.48	3.64	4.1	36.3	0.14
CV(%)	-	9.90	33.32	33.32	16.29	10.99	13.14	48.86	40.34	43.90	17.75	16.75	19.97	76.53	48.96

Note: SOV-source of variation; DF-degree of freedom; G(%) germination percentage; NSP-Stem count, NLP-leaf count; TLW-leaf width; TLL-leaf length; CHL-chlorophyll content; BMS-biomass; NPP-number of pods per plant; POWT-Pod weight, POL-pod length, POW-pod width, SDL-seed length, SDW-seed width. ***Significant at P≤0.001, ** significant at P≤0.01, *Significant at P≤0.05 NS non-significant, respectively.

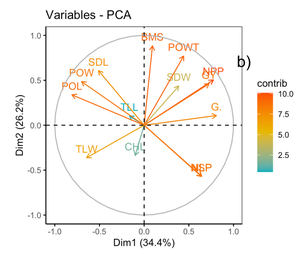
Table 2: Mean separation of Quantitative traits of Bambara groundnut landraces in Hluhluwe

LANDRACE	G(%)	NSP	NLP	TLW	TLL	CHL	BMS	NPP	POWT	POL	POW	SDL	SDW	GY
Cream	96.34^{a}	74.22^{a}	222.66^{a}	2.158^{b}	6.838^{a}	54.88^{a}	0.318^{a}	31.24^{a}	45.84^{a}	16.427^{c}	11.622^{a}	8.58^{b}	6.61^{b}	17.35^{a}
Red	91.40^{b}	75.88^{a}	227.64^{a}	2.36^{a}	6.59^{b}	49.03^{b}	0.18^{c}	19.86b^{c}	33.51^{c}	16.29^{c}	11.31^{a}	7.78^{c}	4.58^{b}	13.63^{b}
Cream Red	70.20^{d}	58.25^{b}	174.77^{b}	2.356^{a}	7.027^{a}	54.73^{a}	0.2^{b}	17.09^{c}	36.11b^{c}	17.71^{b}	10.37^{a}	12.05^{a}	9.09^{a}	13.61^{b}
Cream black	78.98^{c}	41.14^{c}	123.43^{c}	2.311^{a}	6.72^{b}	51.33^{b}	0.30^{ab}	20.63^{b}	42.49^{ab}	19.00^{a}	12.00^{b}	12.26^{a}	11.24^{a}	10.20c
Mean square error	69.59	4053.66	450.41	0.14	0.56	47.58	0.017	80.12	299.79	3.63	4.12	433.12	36.32	192

Note: Means with the same letter are not significantly different and the Groups according to probability of means differences and alpha level(0.05). G(%) germination percentage; NSP-Stem count, NLP-leaf count; TLW-leaf width; TLL-leaf length; CHL-chlorophyll content; BMS-biomass; NPP-number of pods per plant; POWT-Pod weight, POL-pod length, POW-pod width, SDL-seed length, SDW-seed width. ***Significant at P≤0.001, ** significant at P≤0.01, *Significant at P≤0.05 NS non-significant, respectively.

Table 3: Pearson's correlations among studied morphological and physiological of Bambara groundnut landraces under rainfed conditions in Hluhluwe.

	G%	NSP	NLP	TLW	TLL	CHL	BMS	NPP	POWT	POW	POL	SDW	SDL	GY
G%	1.00													
NSP	0.38*	1.00												
NLP	0.39*	0.99***	1.00											
TLW	-0.50**	-0.02^{NS}	-0.02^{NS}	1.00										
TLL	-0.18^{NS}	0.01^{NS}	0.01^{NS}	0.34^{NS}	1.00									
CHL	-0.30^{NS}	0.17^{NS}	0.17^{NS}	0.19^{NS}	0.12^{NS}	1.00								
BMS	0.08^{NS}	-0.33^{NS}	-0.33^{NS}	-0.32^{NS}	0.20^{NS}	-0.24^{NS}	1.00							
NPP	0.59***	0.25^{NS}	0.25^{NS}	0.62***	0.11^{NS}	-0.23^{NS}	0.57***	1						
POWT	0.34^{NS}	-0.11^{NS}	-0.11^{NS}	0.46*	0.22^{NS}	0.02^{NS}	0.76***	0.78^{NS}	1					
POW	-0.54**	-0.62***	-0.62***	0.31^{NS}	0.10^{NS}	-0.5^{NS}	0.33^{NS}	-0.24^{NS}	0.02^{NS}	1				
POL	-0.60***	-05.7***	-0.57***	0.44*	0.16^{NS}	-0.12^{NS}	0.22^{NS}	-0.41^{NS}	-0.14*	0.86^{NS}	1			
SDW	-0.51**	0.05^{NS}	0.05^{NS}	-0.32^{NS}	-0.33^{NS}	-0.26^{NS}	0.25^{NS}	0.31^{NS}	0.45**	-0.02^{NS}	-0.13^{NS}	1		
SDL	-0.28**	-0.56**	-0.56**	0.24^{NS}	0.20^{NS}	0.02^{NS}	0.53**	-0.21^{NS}	0.27^{NS}	0.52**	0.58***	0.25^{NS}	1	
GY	0.54**	0.26^{NS}	0.26^{NS}	-0.58***	-0.04^{NS}	-0.12^{NS}	0.46**	0.86***	0.66***	-0.18^{NS}	-0.37^{NS}	0.36^{NS}	-0.11^{NS}	1



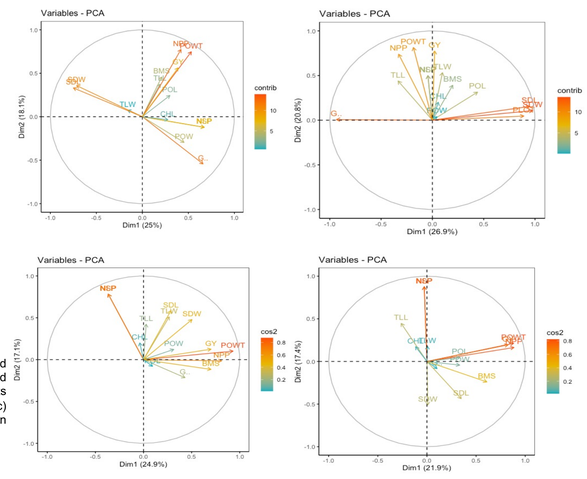


Figure 4: a) Percentages/absolute values of explained variance, b) loadings plot of the first and second component showing relationships of Agronomic traits among and within Bambara groundnut Landrace, c) and d) contribution of each trait to the variation explained by PC1 and PC2.

Figure 5: Cluster plot of the first two PCs showing the relationship between and within Bambara groundnut landraces based on similarities and differences on studied agro-morphological traits.

Conclusion

- The findings in this study established the presence of sufficient variation within and between landraces for almost all agronomic traits.
- Cluster analysis was able to grouped and discriminated landraces into 4 clusters based on their morpho-physiological traits similarities.
- Cream red and black are the most suitable landraces to consider for production under rainfed condition in Hluhluwe, since are able to maintain their performance under such conditions

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