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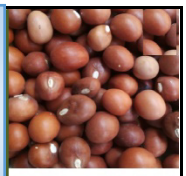

Assessment of Morphological Variations and Crop Performance among Commonly Cultivated Bambara Groundnut (*Vigna subterranea (L) Verdc.)* Landraces in Gombe, Nigeria

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ABSTRACT

Bambara groundnut is cultivated by low-income earning farmers at the subsistence level without knowledge of genetic diversity on major morphological and yield traits. This study aimed to assess morphological variations and crop performance among commonly cultivated Bambara groundnut landraces. The five most commonly cultivated Bambara groundnut landraces were collected from farmers and were planted randomly in a complete block design (RCBD) with three replications in the Botanical Garden of Gombe State University. The results of the analysis of variance from this study revealed significant variation among some of the traits. The results on germination percentage showed that the landraces germinated between seven to ten (7-10) days after planting with 73% and 100% as the lowest and highest mean percentages. The highest mean number of leaves observed was in Stripped Black 122 whereas the lowest mean was 52. The highest mean observed at ten weeks after planting was 31.20 and the lowest mean was 23.00 in stripped brown and stripped black landraces. The highest mean plant canopy spread observed was 70cm in the white landrace, whereas the lowest mean plant canopy observed was 35cm in the black landrace. The highest mean biomass fresh weight observed was 214.95 among the white landrace while the lowest mean observed was 80.30 among the red landrace. A similar trend was recorded on biomass dry weight where the white landrace recorded 101.23 while the red landrace recorded the lowest mean biomass dry weight at 30.62 these traits have highlighted the significance chosen various parameters in selection for breeding and improvement of Bambara groundnut.

INTRODUCTION

The Bambara groundnut [*Vigna subterranea* (L) verdcourt] is an indigenous African grain legume, which is one of the most important food crops after groundnut and cowpea, especially in the drier regions which receive a limited amount of rainfall [1]. In the tropical regions of the African continent, legumes and cereals are the key sources of food and income for the majority of low-income earning farmers [2]. Bambara groundnut is commonly cultivated in Central and West African regions, Cameroon stands as the second largest producer of this crop after Burkina Faso, which contributed to more than 21 % of its total production around the continent [3]. Bambara groundnut is a drought-tolerant crop that can be cultivated in fringe and low-input soils. While the crop produces nutritious food and is cultivated throughout the African continent, it generally remains neglected by the scientific community. However, experimental evidence and fragmented research results suggest that it is a crop with great potential [4].

As a constituent of Africa's food, the seeds are usually eaten by cooking in excess water or roasted as a snack. Hence, it has a great potential for food and nutritional benefits among the pro-poor families. The seeds contain 55.5–69.3% carbohydrate, 5.3–7.8% fat, metabolizable energy 362–414 kcal/100g, and 17–24% high-quality protein and high quantities of nutritional fibre. Also

calcium, and Iron with vitamins such as thiamin, riboflavin, niacin, and carotene [5]. Studies on chemical analyses revealed that they contain 33.72% of total important amino acids with 66.10% non-essential amino acids [6,7]. Lysine remains the key essential amino acid found in Bambara groundnut and accounts for 10.7% of the entire essential amino acid found in it. Bambara groundnut fodders play a significant role in feeding animals [3,1]. In some communities in Northern Nigeria, the plant can be used for medicinal purposes to treat different ailments.

Research has revealed that Bambara groundnut production can differ from 380 to 1000 kg ha^{-1} based on the genotype or landrace used [8]. Similarly, in a study conducted by [9] to study the influence of nitrogen fixation and the N-balance of its landraces cultivated on Malaysia's acidic tropical soils, they observed 374-896 kg ha−1 in pod yield. The crop produces higher grain yields with a projected world production of 331,000 tons. [10] carried out a study to assess the interrelationship among grain yield of Bambara groundnut compared to its numerous yield traits.

The result revealed a strong positive correlation between mean pods per plant, 100 seed weight, and harvest index with grain yield. In spite of the numerous beneficial attributes provided by this crop, little or no studies were carried out on it in Gombe (Northeastern Nigeria) when compared to other crops such as Maize, Cowpea, Millet, sorghum, and groundnut. The main objective of this study was to assess morphological variations and crop performance of commonly cultivated Bambara groundnut landraces in Gombe Nigeria to integrate them into the breeding and improvement program. This would boost their promotion and valorization in the farming methods and finally contribute to increased food safety.

MATERIALS AND METHODS

Study Area

The experiments were conducted at the new botanical garden of the biological sciences department in Gombe State, Nigeria, located between latitude 10°E 18' and longitude 11° 10' 36.43"E and have an altitude/elevation of 438-478m above sea level. Similarly, it has a total land size of 270 square meters, which is equivalent to 2.7 hectares.

Plant Material

The seeds (Landraces) of Bambara groundnut used in this research include Red, Black, White, Stripped black and stripped brown **Fig. 1**. These seeds were collected from Kwami and Yamaltu Deba local government areas of Gombe state. The seeds were carefully sorted and thoroughly screeded to remove foreign materials and undesirable ones before planting.

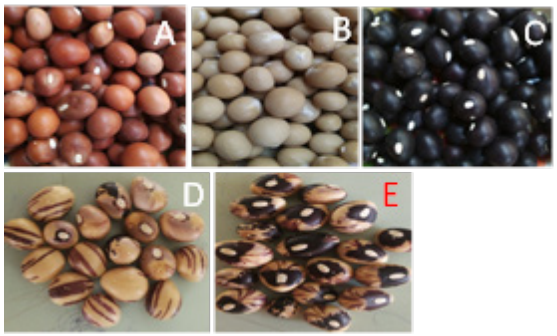

Fig. 1. Appearance of seeds (Landraces) of Bambara groundnut. A: Red Landrace, B: White Landrace, C: Black Landrace, D: Stripped Brown Landrace, E: Stripped Black Landrace.

Experimental Design and Treatment

The experiment was laid down in a Randomized Complete Block Design (RCBD), with three replications. The plot size used was 6 m x 6 m and individual plots within a block were separated from each other by 1m, while the blocks were separated from each other, by a distance of 2 m. Inter-row, spacing was 50 cm whereas intra-row spacing was 20 cm. At planting two seeds were sown per stand at a depth of 3-5 cm and thinned to one plant per stand after germination.

Management Practices

The field was cleared of all unwanted debris and harrowed for easy planting and other agronomic practices. Weeds were manually removed periodically throughout the study period. Watering/irrigation was carried out manually until physiological maturity.

Data Collected

The data collected include; Days to germination, percentage germination, Plant Height, Plant Canopy spread, Number of leaves per plant, and plant Biomass.

Data analysis

The data obtained were subjected to Analysis of Variance (ANOVA) using SAS version 9.4. Differences between treatment means were determined using the Duncan method.

RESULTS AND DISCUSSION

The result on the number of days to germination and percentage of germination indicated that there was no significant variation ($P< 0.05$) among all the landraces used in this study. The result showed that the landraces germinated between seven to ten (7-10) days after planting with 73.33 and 100.00 (**Table** 1) as the lowest and highest mean percentages for tripped Black and Black landraces respectively. It was also observed that the landraces start to germinate at six days after planting and a continuous trend was observed among all landraces used in this study.

The results on the mean value for the number of days to germination in this study is within the range of (7 to 14 days after sowing) stated by [11] in their experiment to characterize Bambara groundnut landraces and to evaluate their performance in the West Upper region of Ghana. Additionally, the results from this experiment agree with those reported by [12] who mentioned in their research that, the interval days to germination recorded was in the range of 5-14 days after planting. Contrariwise, these findings disagree with those reported by [13] who reported that Bambara groundnut varieties used in their experiment took 14-24 to germinate. Furthermore, this result is in agreement with the findings of [6] who stated that the mean value for the percentage germination in Bambara groundnut is within the range of 70 to 100% as observed from their study. Similarly, this result is in agreement with the information stated by the [14] on Bambara groundnut descriptors of growth and development habit.

Table 1. Mean Germination percentage among the landraces used.

Landraces	Number of Days to Germination	Germination Percentage (%)
Red	8	84.33 ± 21.36^{abc}
Black	10	100.00 ± 00^{a}
White	9	95.33 ± 4.04^{ab}
Stripped Black	7	73.33 ± 5.77^{c}
Stripped Brown	7	76.66 ± 5.77^{bc}

Note: Means with the same alphabet are not significantly different from each other at (P< 0.05).

The results on the mean number of leaves per plant did not show any significant difference (P< 0.05) except at ten (10) weeks after planting which revealed significant differences among the landraces used in **Table 2**. At ten weeks after planting the landraces indicated an increase in the mean number of leaves produced by individual landraces used. The highest mean number of leaves observed was in Stripped Black, which recorded 121.67 whereas the lowest mean number of leaves observed was in Red Landrace, which scored 52.

This result corroborates with those of [15] who work on preliminary yield evaluation of selected Bambara groundnut landraces and the occurrence of pre-emergence damping-off under rain-fed and irrigated conditions, they reported an increase in plant canopy spread, height and number of pods with an increase in the number weeks after germination.

Similarly, another study by [16] to explore the production and utilization of Bambara groundnut in Uganda found that variation exists among different Bambara groundnut landraces in terms of plant growth and development with advance days after germination. [17] also reported similar results from their study on Genetic dissimilarity and classification of Bambara groundnut accessions under environments considering yield and yield-related traits.

Table 2. The mean number of leaves per plant was observed throughout the study period.

Land-races	Number of leaves per plant (cm) mean ± S.D				
	2WAP	4WAP	6WAP	8WAP	10WAP
Red	13.00±2.64^{a}	20.33±4.50^{a}	44.66±15.88^{a}	58.33±17.47^{a}	52.00± 10.00^{b}
Black	16.00±4.35^{a}	17.00±3.60^{a}	38.00±10.58^{a}	75.66±31.56^{a}	99.66± 25.42^{ab}
White	16.66±2.51^{a}	23.66±2.08^{a}	50.33±4.93^{a}	82.33±29.26^{a}	109.33±35.72^{ab}
Stripped Black	11.33±3.78^{a}	20.66±6.42^{a}	47.33±14.74^{a}	84.66±41.01^{a}	121.67±46.26^{a}
Stripped Brown	13.00±4.00^{a}	23.66±3.51^{a}	57.00±14.73^{a}	87.66±24.78^{a}	115.00±43.55^{ab}

Note: Means with the same alphabets in each column are not significantly different from each other at (P< 0.05). WAP= Weeks After Planting

Mean plant heights did not show any significant difference among all the landraces used in this study except at two weeks and ten weeks after planting which showed significant variation among the landraces used (**Table 3**). The highest mean plant height observed at two weeks was 16.33 whereas the lowest mean observed was 12.00 for white and stripped black landraces respectively. Similarly, the highest mean observed at ten weeks after planting was 31.20 and the lowest observed mean was 23.00 in stripped brown and stripped black landraces respectively. It was also observed that, stripped black landrace recorded lower mean values for a mean number of leaves and plant height.

This result is similar to those reported by [18] which states that there was no significant variation in studied parameters such as mean plant height, number of leaves, number of branches and canopy spread between two Bambara ground varieties used from their study. Another study report by [19] on yield adaptability and stability of selected Bambara groundnut revealed that parameters such as mean canopy spread, plant height and number of pods in Bambara groundnut do not show any significant difference, however, little differences were observed among different varieties.

Table 3. Mean plant height recorded (weeks) throughout the study period.

Landraces	Period (Weeks) Plant Height (cm) mean ± S.D				
	2WAP	4WAP	6WAP	8WAP	10WAP
Red	16.00±1.73^{a}	18.66±2.30^{a}	21.00±3.60a	22.00±4.45^{a}	23.33±4.16^{a}
Black	14.66±2.30^{ab}	16.66±2.51^{a}	19.66±2.88^{a}	23.50±4.92^{a}	25.33±4.72^{a}
White	16.33±2.51^{a}	17.00±1.73^{a}	22.00±2.00^{a}	24.16±2.36^{a}	24.00±2.64^{a}
Stripped Black	12.00±1.00^{b}	18.66±3.21^{a}	21.66±2.51^{a}	20.26±5.65^{a}	23.00±6.00^{a}
Stripped Brown	16.00±1.73^{a}	19.66±4.61^{a}	21.66±3.05^{a}	27.93±1.15^{a}	31.20±1.55^{a}

Note: Means with the same alphabet are not significantly different from each other at (P< 0.05).

Results on plant canopy spread indicated diverse performance among the landraces used. The highest mean plant canopy spread observed was 70 cm in the white landrace, whereas the lowest mean plant canopy observed was 35 cm among the black landrace used respectively. The remaining landraces have similar performance with just little variations as can be seen in **Fig. 2**.

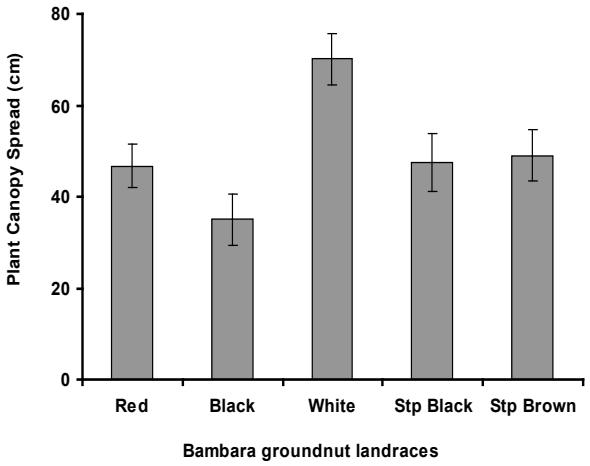

Fig. 2. Mean plant canopy spread observed among the landraces used.

The results on plant biomass showed significant variation among the landraces used in this study (**Table 4**). The highest mean biomass fresh weight (214.95) was recorded among the white landrace while the lowest mean biomass fresh weight 80.30 was observed among the red landrace. A similar trend was equally observed on biomass dry weight where the white landrace recorded the highest mean (101.23) while the red landrace recorded the lowest mean biomass dry weight 30.62 respectively.

This result agrees with the work of [20] where they studied and selected high-yielding and farmers-preferred Bambara groundnut genotypes, they observed highly significant differences among yield and yield components. Similarly, [6] observed phenological traits among twenty Bambara groundnut landraces, their results revealed that the genotypes were diverse in terms of their performance based on the traits studied. They found that early flowering, number of pods per plant, and grain yield per plant were the most observed factors, signifying their relevance when choosing superior agronomic qualities.

They observed significant correlations between the number of stems; pod yield and the number of pods per plant; grain and pod yield and between grain yield and the number of pods per plant emphasizing the significance of these traits in selection for the improvement of Bambara groundnut. The quantitative morphological traits have revealed valuable data for the characterization of Bambara groundnut landraces for their incorporation into breeding programs.

Table 4. Mean biomass fresh and dry weights recorded at harvest.

Landraces	Biomass weight observed (g)	
	Fresh plant weight (g)	Dried plant weight (g)
Red	80.30± 1.26^{e}	30.62±1.42^{e}
Black	100.29 ±2.41^{d}	41.15±1.79^{d}
White	214.95±2.92^{a}	101.23±2.68^{a}
Stripped with Black Eye	174.71±5.22^{b}	82.70±1.97^{b}
Stripped with Brown Eye	131.93±4.53^{c}	64.21±4.643^{c}

Note: Means with the same alphabet are not significantly different from each other at (P< 0.05).

CONCLUSION

This research permitted us to study and understand five Landraces of Bambara groundnut collected from Gombe and evaluated for morphological and yield performance. Based on the parameters studied, there exist important morphological and yield variability traits among the five landraces studied. The existence of these broad genetic variations among Bambara groundnut landraces in Gombe (Northeast Nigeria) for major agronomic traits will greatly enhance the breeding techniques, genetic assets and improvement to guide the development of new cultivars and germplasm conservation of this highly important but neglected and under-researched crop. Similarly, this crop will play a significant role in mitigating the effect of climate change and improving food sufficiency in the region. Intensive research on Bambara groundnut in areas of genetics breeding and agronomy is necessary both in Northeast and African regions.

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