Studies On The Adaptation Of Bambara Groundnut [*Vigna Subterranea* (L.) Verdc] In Owerri Southeastern Nigeria.

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Abstract: Field experiment was conducted on the adaptability of bambara groundnut in humid rain forest tropical zones with six local accesssions in a Randomized Complete Block Design with three replications. Data was collected on the yield and yield attributes, and analysed with analysis of variance (ANOVA) and means separated by least significant difference (LSD p=0.05). Correlation studies were carried out to determine the relationship between yield and yield attributes. Results of analysis of variance showed significant differences in plant height, canopy diameter and petiole length, and no significant differences in number of stems and dry matter weight (biomass) among accessions. Correlation analysis between yield attributes and fresh pod weight indicated positive correlation in all cases. However, plant height and number of stems had a near perfect positive correlation signifying that the higher the height of the plant the greater the yield. The performance ranking of the accessions showed that AC-01 had the best overall performance while AC-05 had the least. Conclusively, bambara groundnut is apparently adaptive in the study area (especially tall growing accessions), and can contribute immensely in food and nutritional security in this agroecological zone.

[N.I.C Onwubiko, O.B. Odum, C.O.Utazi And P.C Poly-Mbah. **Studies On The Adaptation Of Bambara Groundnut [*Vigna Subterranea* (L.) Verdc] In Owerri Southeastern Nigeria.** New York Science Journal 2011;4(2):60-67]. (ISSN: 1554-0200). http://www.sciencepub.net/newyork.

Key words: *Vigna subterranea,* bambara groundnut, adaptability, humid rain forest zone.

INTRODUCTION

The expansion of crop production has been to increase and stabilize yield to meet the various needs of man; first to ensure that food supply is at pace with ever increasing human population so as to reduce or eradicate hunger if possible, next to produce feed for livestock and then raw materials for industries. In addition crop production in recent times is diversified to satisfy varying human taste, cure certain ailments of man and to beautify the environment. Consequently, research on ways to improve crop production is on the increase especially now that global food crisis and nutritional insecurity is threatening human existence. It has been reported that about 1.2 billion people in the world do not have enough food to meet their daily food requirement and a further 2 billion people are deficient in one or more micro-nutrients (Williams and Haq, 2003), necessitating exploration of other ways to increase crop production.

One of the major challenges of crop production in present time is crop failure consequent on climate change. It has been observed that the overall effect of climate change is poor performance and low adaptation of crops even in their natural environment of origin. Invariably, this will lead to an upsurge reduction in global crop production and supply, increase in food price, risk of exposure to hunger, malnutrition and food insecurity (UNFCCC, 2007; IPCC, 2007). Writing on the same issue, WFP (2009) projected that there will be a 9 to 11% decrease in crop performance, 25 to 50% increase in food price and 10 to 60% increase in hunger, consequent on climate change in the near decades in most developing countries of the world. It is also estimated that the number of people at risk of hunger as a result of climate change will increase by 10 to 20% in the near future and Africa will be most affected especially the semi-arid regions north and south of the equator. Apparently, this problem of global food crisis and nutritional insecurity demands that crops be grown outside their usual growing environment, especially hardy crops that can adapt to a wide range of environmental conditions.

Several scholars observed important attributes of bambara groundnut to include; tolerance to drought, high temperature and rainfall (Linnemann and Azam-Ali, 1993; Azam-Ali *et al*., 2001), reasonable resistance to pest and disease (Uguru and Ezeh, 1996; Ntundu *et al*., 2003), high yielding potentials (Swanevelder, 1998; Collinson *et al*., 2000) and nutritional values (Amarteifio *et al*., 2006; Mahama *et al*., 2008). Unfortunately, there is scarcely any report on the evaluation of this crop in the humid rainforest zone of Nigeria irrespective of its important agronomic and nutritional potentials. In fact most farmers in this agroecological zone have not seen the crop. Hence, the need to conduct field trials on the adaptability of bambara groundnut in this zone, which is the primary target of this study with a view to identifying suitable line(s) for cultivation of bambara groundnut in humid rainforest zone of Nigeria.

MATERIALS AND METHOD

The materials used in this study comprise of six local lines of bambara groundnut (AC-01, AC-02, AC-03, AC-04, AC-05 and AC-06) characterised by different seed coat colour, seed eye colour and seed size as shown in Figure 1 and Table 1 below. Other materials are meter rule and vernier calliper.

Two seeds were sown per hole which was later thinned down to one after emergence with a planting distance of 30cm on ridges spaced 100cm apart. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications and was carried out in Teaching and Research Farm of School of Agriculture and Agricultural Technology, Federal University of Technology Owerri, Southeastern Nigeria.

Data was collected on days to first and 50% emergence, days to first and 50% flowering, plant height, canopy diameter, petiole length, number of stems, root and shoot dry matter (at flowering) and fresh pod weight (at harvest). All the data collected were subjected to statistical analysis using the analysis of variance (ANOVA) and the least significant difference (LSD) for mean separation. In addition, statistical correlation was used to determine the relationship between yield attributes and yield (Fisher 1963).

Table: 1. Localities and Seed Characteristics of the six bambara groundnut accessions.

Accession No.	Locality	State	Seed Coat Colour	Seed Eye Colour	Seed Size
AC-01	Mubi	Adamawa	Cream	White	Big
AC-02	Dundaye	Sokoto	Red	White	Small
AC-03	Dundaye	Sokoto	Cream	White	Small
AC-04	Dundaye	Sokoto	Cream	Purple Butterfly Eye	Small
AC-05	Dundaye	Sokoto	Black	White	Small
AC-06	Mubi	Adamawa	Cream	Purple Butterfly Eye	Big

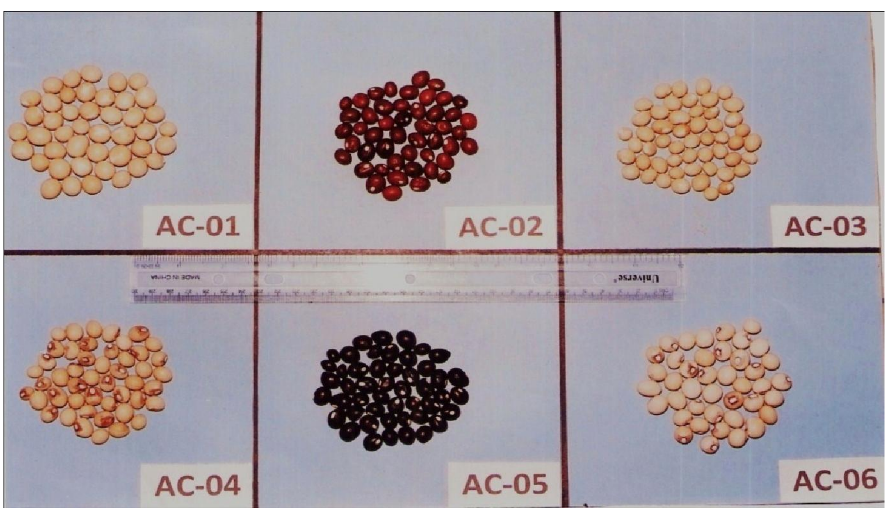

Figure 1: Seeds of the Six Local Lines of Bambara groundnut

RESULTS

Three accessions (01, 03 and 06) emerged first at six days after planting (DAP) while the other three accessions (02, 04 and 05) emerged 7 DAP. The least days to 50% emergence of 8 days was recorded for accession 06 while the highest of 10 days was observed for accessions 02 and 05. On days to first flowering, two accessions 01 and 02 flowered first at 30 days while accession 04 flowered last at 34 days. The least and highest number of days to 50% flowering of 39 and 45 days were recorded for accessions 06 and 01 respectively (see Table 2 below).

Table 2: Days to first and 50% emergence, and days to first and 50% flowering.

ACC. NO.	DTFE	DT50%E	DTFF	DT50%F
AC-01	6	9	30	45
AC-02	7	10	30	42
AC-03	6	9	32	42
AC-04	7	9	34	40
AC-05	7	10	31	42
AC-06	6	8	33	39

ACC.NO. = accession number
DT50%F = days to 50% flowering
DT50%E = days to 50% emergence
DTFF = days to first flowering
DTFE = days to first emergence

The result on plant height, canopy diameter, petiole length and number of stem is shown in Table 3 below**.** Accession 01 recorded the highest mean values; 12.88cm for plant height, 28.86cm for canopy diameter and 3.14mm for petiole length while accession 05 recorded the lowest mean values; 10.08cm for plant height, 18.13cm for canopy diameter and 2.08mm for petiole length. On number of stems, accessions 06 recorded the highest mean value of 28.87 while accession 05 had the least mean value of 23.97.

Table 3: Means for plant height, canopy diameter, petiole length and number of stem.

ACC.NO.	PH(cm)	CD(cm)	PL(mm)	NS
AC-01	12.88	28.86	3.14	27.90
AC-02	10.16	23.22	2.53	25.67
AC-03	10.92	23.67	2.21	24.10
AC-04	10.69	24.40	2.25	25.47
AC-05	10.08	18.13	2.08	23.97
AC-06	11.98	23.49	2.44	28.87
LSD(0.05)	1.81	1.99	0.186	n.s

ACC.NO = accession number
CD = canopy diameter
NS = number of stems
n.s = not significant
PH = plant height
PL = petiole length
LSD = least significant difference

Table 4 below shows the result on root and shoot dry matter at flowering, and fresh pod weight at harvest. On shoot dry matter weight, accession 01 had the highest mean of 2.00g while the least (0.82g) was recorded for accession 05. The highest and lowest mean root dry matter weight of 0.54g and 0.12g were recorded for accessions 01 and 02 respectively. Similarly accession 06 had the highest mean fresh pod weight of 42.00g per stem (or13.33kg per hectare), while accession 05 had the least mean value of 21.25g per stem (or 6.74 kg per hectare).

Table 4: Means for leave, shoot and root dry matter, and fresh pod weight.

ACC.NO.	SDM	RDM	FPW(g)/S	FPW(kg)/H
AC-01	2.009	0.54	31.67	10.054
AC-02	1.09	0.12	22.50	7.140
AC-03	1.33	0.46	22.50	7.140
AC-04	1.27	0.14	23.00	7.300
AC-05	0.82	0.16	21.25	6.740
AC-06	1.23	0.22	42.00	13.33
LSD(0.05)	n.s	n.s		

ACC.NO = accession number
SDM = shoot dry matter
RDM = root dry matter
FPW/S = fresh pod weight per stand
FPW/H = fresh pod weight per hectare
LSD = least significant difference
n.s = not significant

The results on mean correlation of yield attributes and fresh pod weight shows that all yield attributes tested had a positive correlation with fresh pod weight. However, two of the parameters (plant height and number of stems) showed a near perfect positive correlation with correlation coefficient values of 0.754 and 0.924 respectively while others: canopy diameter, petiole length, shoot dry matter weight and root dry matter weight recorded a moderately positive correlation with correlation coefficient values of 0.40, 0.433, 0.40, and 0.20 in that order (see Table 5 below). In perfect positive correlation both variables increase and decrease in the same proportion while in moderately positive correlation the variables are positively correlated but the changes do not occur in exactly the same proportion (Fisher, 1963; Dipak and Soma, 2006).

Table 5: Correlation of yield attributes and fresh pod weight.

ACC.NO.	PH	CD	PL	NS	SDM	RDM	FPW(g)/S
AC-01	12.88	28.86	3.14	27.90	2.009	0.54	31.67
AC-02	10.16	23.22	2.53	25.67	1.09	0.12	22.50
AC-03	10.92	23.67	2.21	24.10	1.33	0.46	22.50
AC-04	10.69	24.40	2.25	25.47	1.27	0.14	23.00
AC-05	10.08	18.13	2.08	23.97	0.82	0.16	21.25
AC-06	11.98	23.49	2.44	28.87	1.23	0.22	42.00
(r)	0.754	0.40	0.43	0.924	0.40	0.20	

Tc	PPC	MPC	MPC	PPC	MPC	MPC

r-tab(0.05) = 0.5529
PH = plant height
PL = petiole length
SDM = stem dry matter
FPW/S = fresh pod weight per stand
MPC = moderately positive correlation
Tc = type of correlation
r-tab(0.05) = coefficient of correlation tabulated at 0.05 probability level
ACC.NO. = accession number
CD = canopy diameter
NS = number of stem
RDM = root dry matter
PPC = perfect positive correlation
(r) = coefficient of correlation

The ranking of the accessions studied based on their performance on a 1-6 scale (where 1 represents the lowest value and 6 the highest value) is shown in Table 6 below. From the Table, accession 01 had the overall best performance in all the parameters assessed, having a ranking value of one (1) while accession 05 had the least performance with a ranking value of six (6).

Table: Performance ranking of the accessions studied.

ACC.NO.	DTFE	DT50%E	DTFF	DT50%F	PH	CD	PL	NS	SDM	RDM	FPW/S	TOTAL	RANK
AC-01	2	2	5	1	6	6	6	5	6	6	4	55	1
AC-02	1	1	5	2	2	2	5	4	2	1	3	30	5
AC-03	2	2	3	2	4	4	2	2	5	5	3	39	3
AC-04	1	2	1	3	3	5	3	3	4	2	2	33	4
AC-05	1	1	4	2	1	1	1	1	1	3	1	18	6
AC-06	2	3	2	4	5	3	4	6	3	4	5	44	2
TOTAL	6	6	6	6	6	6	6	6	6	6	6	72	1-6

ACC.NO = accession number
DTFE = days to first emergence
DT50%E = days to 50% emergence
DTFF = days to first flowering
DT50%F = days to 50% flowering
PH =plant height
CD = canopy diameter
PL = petiole length
NS = number of stems
SDM = stem dry matter
FPW/S = fresh pod weight per stand

DISCUSSION

The emergence of the accessions studied was between 6 and 7 days for days to first emergence (DTFE), and 8 to 10 days for days to 50% emergence (DT50%E) (see Table 2). Three accessions 01, 03 and 06 had early emergence, emerging first at 6 days after planting (DAP) while other accessions, 02, 04 and 05 emerged on the seventh (7) day after planting. Apparently from Table 2, three accessions 01, 03 and 04 had their 50% emergence at 9 days after planting and two other accessions, 02 and 05 had 50% emergence at 10 days after planting. Accession 06 recorded the least number of days to 50% emergence of 8 days after planting. The variation on the emergence of the crop studied has also been observed by Sesay (2009) who reported that germination or seedling emergence in bambara groundnut is often erratic and variable. However, early seedling emergence is an important agronomic trait for efficient crop management and production (Paul and Bruce, 2008; Thomas *et al*; 2009).

The number of days to first flowering (DTFF) was observed to be between 30 and 34 days, while that of 50% flowering (DT50%F) was between 39 and 45 days. Two accessions, 01 and 02 flowered first at 30 days while accession 06 flowered last at 45 days after planting. Similarly accessions 06 and 01 had the least and highest number of days to 50% flowering of 39 and 45 days respectively (Table 2). The result on first and 50% flowering is in agreement with the findings of

Dpp (2009) who observed that flowering in bambara groundnut is between 30 and 45 days. Furthermore, the variation observed in flowering of the crop has been attributed mostly to variable temperatures and photoperiods (Linnemann, 1992; Martin, 1997). In addition, Dimakatso (2006) reported that flowering in bambara groundnut is indeterminate. However, early flowering has been recognised as a good agronomic attribute in crops for early maturity, uniformity of yield and crop production in general (Kumaga *et al.,* 2003). Similarly, poor yield in this crop has been identified as a function of delayed flowering (Makanda *et al*., 2009). Hence lines that flower early should be considered in the production of bambara groundnut.

Significant differences in other morphological characters studied were observed among the accessions. The recorded mean values indicated that accession 01 recorded the best performance in plant height, canopy diameter and petiole length, having mean values of 12.88cm for plant height, 28.86cm for canopy diameter and 3.14mm for petiole length. On number of stems, accession 06 had the highest mean value of 28.87 and this was followed by accession 01 with 27.90. Other accessions 02, 03, 04 and 05 recorded slight variabilities in plant height, canopy diameter, petiole length and number of stems with mean values ranging between 10.0cm and 10.9cm for plant height, 18cm and 24cm for canopy spread and between 23cm and 25cm for number of stems (see Table 3). Variability on morphological traits like plant height, canopy spread, petiole length and number of stems among accessions of bambara groundnut have been observed by several workers (Amadou *et al*.,2001; Ntundu *et al*.,2003; Massawe *et al*.,2005).

The observed mean values for root and shoot dry matter weight as shown in Table 4 indicated that accession 01 had the highest mean values of 2.009g for shoot dry weight and 0.5g for root dry matter weight. The other accessions; 02, 03, 04, 05 and 06 had mean values ranging from 0.8 to 1.3g for shoot dry matter weight, and 0.1g to 0.4g for root dry matter weight. Also at p=0.05 there were no significant differences in shoot and root dry weights among accessions. This clearly indicates that there were no differences in both root and shoot biomass for these accessions. However, the high root and shoot biomass observed for accession 01 is an indication of good agronomic character (Makanda *et al*., 2009). On fresh pod weight per stand (FPW/S), the highest mean value of 42.00g per stem (or 13.33kg per hectare) was recorded for accession 06 while accession 05 had the least mean value of 21.25g per stem (or 6.74kg per hectare). The other accessions 02, 03, and 04 recorded mean values for fresh pod weight per stand ranging between 22.50g and 23.00g per stem (or between 7.14kg and 7.30kg for fresh pod weight per hectare). Primarily this crop is cultivated for its fresh pods and hence accessions with greater fresh pod weight are of immense value to farmers (See Table 4).

A correlation of morphological components (plant height, canopy diameter, petiole length, number of stem, shoot and root dry matter weight) with fresh pod yield showed a positive correlation between these morphological parameters and pod yield. Correlation studies between characters have been observed to be of great value in determining the most effective procedures for selection of superior agronomic traits in crops (Johnson *et al*., 1955; Paroda and Joshi, 1970; Kamboj and Mani, 1983; Adebisi *et al*., 2004; Jonah *et al*., 2010). The results herein showed different forms of association between variables and pod yield. A highly significant perfect positive correlation was observed for plant height and number of stem at r-tab=0.05 which clearly indicates a direct positive effect of both plant height and number of stem on pod yield. On the other hand, a moderately positive correlation observed for canopy spread, petiole length, shoot and root dry weight matter indicated a moderate but positive effect of these parameters on pod yield (see Table 5). The result shows that accessions with greater heights and number of stems had better yield. Ultimately increase in yield is the major goal of crop production, hence agronomic and morphological characters that improves yield should be emphasized on. Kadams and Sajo, (1998) described yield as a measure of and an indication of good agronomic and morphological characteristics in crops. Overall accession 01 had a better performance with a total score of 55 and a ranking value of one (1) while accession 05 recorded the least performance with a total score of 18 and a ranking value of six (6) (see Table 6).

CONCLUSION

Apparently from the results obtained in this study, there is clear evidence that a great measure of adaptability was attained among the accessions studied. Therefore the domestication of this crop in this zone is feasible and will certainly improve the cropping system and nutritional status of the people in the humid rainforest agroecological zone of Nigeria.

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12/25/2010