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PREFACE

There is a growing concern on the adverse impacts of climate on biodiversity. This phenomenon is greatly manifested in form of shifting weather patterns threatening global food security, health and species existence. Humanity is at the receiving end of the consequences of climate change hence there is a need to step up actions on all fronts- overtime, everywhere all at once.

This calls for collaboration, partnership and networking to strengthening synergy among relevant stakeholders in a bid to tackling climate change menace. This forms the basis for the theme of this year world Environmental conservation conference: **CLIMATE CHANGE PARTNERSHIP ACTIONS FOR SUSTAINABLE FUTURE AND RESTORING LIFE ON EARTH.** The theme is conceived with a view to create an interface for information sharing and offer opportunities for participants to refine their commitments and pledges in the quest to achieving Sustainability in the face of climate change.

This year World Environmental Conservation Conference is memorable in the sense that it received overwhelming funding from the host - West African Science Service on Climate Change and Adapted Land use). WASCAL is posed to provide information and knowledge at the local, national and regional level to cope with the adverse impacts of climate change. Thus, this conference will offer opportunities for participants to learn from good practices demonstrated and showcase by WASCAL during the course of the conference. It will also strengthen staff-student exchange and provide prospect for Doctorate Research Doctoral Research in West Africa Climate System Programme (DRP WACS) – WASCAL among others.

Special appreciation goes to the management of The Federal University of Technology, Akure the host institution, National Park Service and African Regional Center for Space Science and Technology Education-English (ARCSSTE-E) that co-host this conference. We equally acknowledge other private, individual and corporate organizations that have contributed towards the success recorded in this event.

All the submitted articles were subjected to strict double blind peer-review process by the reviewers that are experts in the area of the particular submitted manuscript. The accepted manuscripts are published in WECC 2023 proceedings and also available for download on the organization website (www.necorng.org).

The accepted manuscripts fall within the underlisted subthemes:

- Climate change adaptation strategies in Agriculture, Forestry and Other Land Use (AFOLU)
- Climate smart city and architectural landscape design
- Retrofitting and decarbonization in tourism and hospitality industry
- Indigenous knowledge and local innovation in climate change adaptation
- Climate risk management, health, safety and hygiene
- Carbon credit-offset marketing/circular economy
- ICT development in environmental conservation (image processing and acquisition, computer vision, graphics, speed, interface technology, HMD devices, GIS: Body Tracking, AI and IOT, VRT, IVE).

We commend our keynote speaker Prof. Douda Kone Director Capacity Building Department, WASCAL Headquarter, Ghana and other guest speakers Prof. Babatunde Rabiu, Director General, Chief Executive Office, African Regional Centre for Space Science and Technology Education-English (ARCSSTE-E) and Dr. Goni I. M., Conservator General National Park Service.

It is hoped that researchers, students and policy makers will find the papers in this book very useful. Even though all the papers were reviewed and edited, the content and option expressed remain essentially that of the authors and not necessarily that of Netlink Environmental Conservation Organization.

Dr. Oladeji S. O.

President Netlink Environmental Conservation Organization

Convener World Environmental Conservation Conference

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EVALUATION OF BAMBARA GROUNDNUT (*VIGNASUBTERRANEA* (L.) VERDC.) ACCESSIONS FOR YIELD PERFORMANCE IN THE RAINFOREST AND SAVANNA AGRO-ECOLOGIES OF NIGERIA

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ABSTRACT

Most Agricultural Scientists, especially commercial farmers are usually on the look – out for the best planting materials and those that will bring a better yield, so as to have a good output of their investments. Fifty (50) accessions of Bambara groundnut (Vignasubterranea (L.) Verdc), representing African collections from the genebank of the National Centre for Genetic Resources and Biotechnology (NACGRAB), Ibadan, Nigeria were screened at Mokwa (southern guinea savanna and Ibadan (rainforest-savanna transition) zones of Nigeria. According to the Bambara groundnut descriptors, (Biodiversity descriptor, 2000), seven (7) important agro-morphological yield parameters, (number of pods per plant, number of seeds per pod, pod length, plant height, seed yield, days to 50% flowering and number of days to maturity) were selected and scored, to serve as a yardstick for measuring their performance.At both stations (Mokwa and Ibadan), the accessions evaluated differed in yield and yield variables.AtMokwa station, tallest plants were produced by TVSu – 1280, TVSu – 1277 and TVSu – 677 TVSuTVSu – 683 had the highest number of pods, longest pods were obtained for TVSu – 1285, TVSu – 1276 and TVSu – 6 in that order.The longest days to 50% flowering, were observed for TVSu – 681, TVSu – 683 and TVSu – 1860 andthe number of days to maturity shorter for TVSu – 115, TVSu – 7 and TVSu – 1. Highest number of pods (73 pods/plant) by TVSu – 85 and TVSu – 86 order and seed yields were heaviest for TVSu– 683, TVSu – 1865 and TVSu – 6. At Ibadan, tallest plants were produced by TVSu – 4, TVSu – 5 and TVSu – 118 , longer days to 50% flowering were found for TVSu – 681, TVSu – 683 and TVSu – 1860 and the number of days to maturity was shortest for TVSu – 193. The highest number of pods per plant were obtained from TVSu – 397, TVSu – 2017 and TVSu – 395 and longest pods were obtained for TVSu – 6, TVSu – 4 and TVSu – 293. The results showed that TVSU – 6 (Nigeria), TVSU – 397 (Cameroun), TVSU – 683 (Zambia), and TVSU – 1865 (Zimbabwe) gave heaviest seed yields in both agro-ecological zones of Nigeria. The need to empower the National Centre for Genetic Resources and Biotechnology (NACGRAB) in Nigeria for improved conservation and utilization of this legume and other NUS, due to their importance in enhancing food security and nutrition is highlighted.

Keywords: *Bambara, Germplasm, Characterisation, Seed yield, Agroecology*

INTRODUCTION

According to the International Treaty of Plant Genetic Resources (ITPGR) of the Food and Agricultural Organization (FAO), there is no need to conserve germplasm, if its subsequent utilization cannot be guaranteed. Hence, the results of germplasmcharacterisation and evaluation will determine its possible future extent of utilization of their genetic resources by relevant stakeholders.

Bambara groundnut (*Vigna subterranean* L. Verdc.) is an African indigenous legume that has been cultivated for centuries in sub-Saharan Africa, mainly the semi-arid regions, and has in the past contributed to food security (Swanevelder, 1998; FAO, 2001; Azam-Ali et al., 2001; Mwale et al., 2007). For many centuries, Bambara groundnut has been cultivated in the tropical regions of sub-Saharan Africa and in Madagascar (Godwin & Moses, 2013). Bambara groundnut originate from Africa, but could also be found in other countries across the globe. Small-scale farmers that do not have access to irrigation and fertilisers and that has little guidance on improved practices cultivated it in the extreme, tropical environment. Bambara groundnut is essentially grown for human consumption and has been described as a complete balanced diet due to the high carbohydrate (65%) and protein (18%) content of its seed (Ouedraogo et al., 2008). The protein content of bambara groundnut is high in lysine (Massawe et al., 2005). Earlier work on its nutrition content reported it to contain 17-25% protein, 42-65% carbohydrate and 6% lipid (Aykroyd and Doughty, 1982; Linnemann and Azam-Ali, 1993; Mwale et al., 2007). It is a highly nutritious plant, which plays a crucial role in people's diet. The highest recorded seed yield under field conditions is 4 t/ha. Average yields are 300–800 kg/ha (Brink *et al.*, 2006). Average yields of dry seeds usually range between 300 and 800 kg/ha in traditional farming and may exceed 3,000 kg in intensive farming (Baudoin and Mergeai, 2001). Williams et al. (1980) also reported yields of 500–1000 kg of dried nuts per hectare. Bambara groundnut yields are low because the production environments are characterized by various abiotic and biotic stresses. However, even under optimal conditions the yields are variable and unpredictable and this is partly due to variability in growth and development of individual plants within landraces (Squire et al., 1997). The yields are low because production and improvement of Bambara nut has been neglected for many years by researchers, even though the crop is important for the small scale farmers due to its considerable commercial potential, especially for developing countries like Nigeria. There is a need to develop improved varieties for particular agro-ecological conditions or production systems. Bambara groundnut is still regarded as a poor man's crop grown for subsistence and very little progress has been made in improving the crop germplasm (Ayana & Bekele, 2000). The yield of any crop should be of utmost importance in consideration as climate change and population increase are posing a lot of hindrances to sustainable food production. A lot of studies to improve yield have been carried out to solve some of these problems (Bailey-Serres *et al.,* 2019; Oldfield *et al*., 2019; Schauberger et al., 2019). Bambara groundnut is one of the major underutilized crops that tend to fully complement and stand as a major crop counterparts in terms of nutrition contents, hence making it to be very important in achieving food security (Atoyebi *et al.,* 2017b). The crop has a lot of potentials to be harnessed, hence the need to have a good understanding of its yield and yield components for an efficient breeding program for the crop.Assessing crops in various agro ecology through multi environmental trials (MET) are key for selection and recommendation of genotypes that performed best in terms of yield in different environment under study (Kumar *et al.,* 2019). However, the adaptation of specific genotypes to various environments can be gene-specific (Olanrewaju *et al.,* 2021) There is also little information on its production level of Bambara groundnut contrarily however, in developed countries, for example experiments done at the University of Nottingham under controlled environments revealed the crop was capable of producing a pod yield equivalent to 4000 kg/ha (Collinson *et al.,* 1999). This study is to assess the yield performances of accessions of Bambara groundnut across two agro ecologies in Nigeria to determine those with better yield and recommend for improved conservation and utilization.

MATERIALS AND METHODS

This study evaluated yield parameters of fifty (50) accessions of Bambara groundnut (*Vignasubterranea)* grown at two (2) locations in Nigeria; NACGRAB Headquarters, Ibadan (Lat. 7 ^{0}22' N, Long. 3 ^{0}50'E) and Mokwa (Lat. 9 ^{0}21'N, Long. 5 ^{0}00' E) during the 2014 and 2015 planting seasons.

The fifty (50) accessions of Bambara groundnut (*Vignasubterranea* (L.) Verdc), representing African collections, selected for this study, were from the genebank of the National Centre for Genetic Resources and Biotechnology (NACGRAB), Moor – Plantation, Ibadan, Nigeria. Three (3) seeds were initially planted on the row (30cm) apart and (50cm) within each row. Prior to flowering, each accession was thinned to single plants and watered twice a week for the first two months and then reduced to once a week after seed maturityuntil harvest. According to the Bambara groundnut descriptors, (Bioversity descriptor, 2000), seven (7) important agro-morphological yield parameters, (number of pods per plant, number of seeds per pod, pod length, plant height, seed yield, days to 50% flowering and number of days to maturity) were scored.

Results

Table 1: Mean values of seven yield parameters scored at Mokwa station

S/N	Yield Parameters	Highest Three Mean Values			Least Three Mean Values		
1	No of pods per plant	73 (TVSu-683)	53 (TVSu-85)	41 (TVSu-86)	33 (TVSu-395)	28 (TVSu-250)	25 (TVSu-397)
2	No of seeds per pod	2	2	1	1	1	1
3	Pod length (mm)	37.0 (TVSu-1285)	28.0 (TVSu-1276)	27.0 (TVSu-6)	15.5 (TVSu-1860)	14.0 (TVSu-7)	13.0 (TVSu-399)
4	Plant height (cm)	36.0 (TVSu-1280)	34.0 (TVSu-1277)	30.0 (TVSu-677)	18.0 (TVSU-677)	17.0 (TVSu-3)	16.0 (TVSu-118)
5	Seed yield (g/m^2)	30.0 (TVSu-683)	18.4 (TVSU-1865)	18.0 (TVSu-3)	13.0 (TVSu-395)	10.0 (TVSu-250)	7.0 (TVSu-3)
6	Days to 50% flowering	55 (TVSu-681)	53 (TVSu-683)	51 (TVSu-1860)	39 (TVSu-8)	38 (TVSu-186)	37 (TVSu-86
7	No of days to maturity	136 (TVSu-115)	130 (TVSu-7)	127 (TVSu-1)	112 (TVSu-395)	109 (TVSu-106)	107 (TVSu-252)

Table 2: Mean values of seven yield parameters scored at NACGRAB station

S/N	Yield Parameters	Highest Three Mean Values			Least Three Mean Value		
1	No of pods per plant	21 (TVSu-397)	13 (TVSu-2017)	12 (TVSu-395)	5 (TVSu-4)	4 (TVSu-2)	2 (TVSu-1)
2	No of seeds per pod	2	2	2	1	1	1
3	Pod length (mm)	22.0 (TVSu-6)	21.0 (TVSu-4)	20.0 (TVSu-293)	11.0 (TVSu-1870)	10.0 (TVSu-1872)	9.0 (TVSu-1)
4	Plant height (cm)	40.0 (TVSu-4)	30.0 (TVSu-5)	22.0 (TVSu-118)	15.0 (TVSu-85)	12.0 (TVSu-186)	11.0 (TVSu189)
5	Seed yield (g/m^2)	6.9 (TVSu-397)	4.8 (TVSu-6)	4.45 (TVSu-118)	2.01 (TVSu-186)	1.68 (TVSu-1277)	1.48 (TVSu-193)
6	Days to 50% flowering	58 (TVSu-681)	55 (TVSu-683)	48 (TVSu-1860)	40 (TVSu-8)	39 (TVSu-186)	38 (TVSu-86)
7	No of days to maturity	142 (TVSu-1276)	140 (TVSu-86)	139 (TVSu-189)	135 (TVSu-395)	135 (TVSu-1280)	125 (TVSu-193)

Results as shown in tables 1and 2 are the three highest and the three least values of the chosen seven (7) parameters, revealing the performance of these germplasm screening across these two (2) agro-ecological zones. It can be seen from table 1, based on the evaluation that was conducted at the Mokwa station that TVSu – 683 had the highest number of pods with 73 pods, followed by TVSu – 85 and TVSu – 86 with 53 pods and 41 pods respectively in that order. However, TVSu – 395, TVSu – 250 and TVSu – 397 had the least number of pods respectively with 33 pods, 28 pods and 25 pods in that order. For the NACGRAB station evaluation, the highest number of pods per plant were obtained from TVSu – 397, TVSu – 2017 and TVSu – 395 with 21 pods, 13 pods and 12 pods respectively; while the least number of pods were found in TVSu – 1, TVSu – 2 and TVSu – 4 with 2 pods, 4 pods and 5 pods respectively in that order.

Considering the number of seeds per pod as a parameter, the Mokwa station had the highest number of seeds per pod to be 2, which is common among most of them; even though some of them had the least number of seeds per pod to be 1, among some of the 50 accessions of Bambara groundnut evaluated. This results is also similar to those obtained at NACGRAB station, as the majority of the accessions had their highest number of seeds per pod to be 2, while the least of them is 1. For the next parameter, which is the pod length (mm), the Mokwa station had the highest of 37.0mm, 28.0mm and 27.0mm obtained for TVSu – 1285, TVSu – 1276 and TVSu – 6 respectively; while the least pod length of 15.5mm, 14.0mm and 13.0mm were obtained for TVSu – 1860, TVSu – 7 and TVSu – 399 in that order. However, the NACGRAB station had the highest three values of 22.0mm, 20.0mm and 20.0mm, obtained for TVSu – 6, TVSu – 4 and TVSu – 293 respectively; while the least amount of 11.0mm, 10.0mm and 9.0mm were obtained for TVSu – 1870, TVSu – 1872 and TVSu – 1.

As for the plant height (cm), the Mokwa station had the highest three values to be 36cm, 34cm and 30cm respectively for TVSu – 1280, TVSu – 1277 and TVSu – 677; while the least of 18cm, 17cm and 16cm were obtained for TVSu – 3, TVSu – 118 and TVSu – 399. However, at the NACGRAB station, the plant height (cm) were highest with values 40cm, 30cm and 22cm in accessions TVSu – 4, TVSu – 5 and TVSu – 118 respectively; while the least three values of 15cm, 12cm and 11cm were obtained from accessions TVSu – 85, TVSu – 186 and TVSu – 189 respectively. Furthermore, the yield parameter is an important factor, taking into considerations by most agriculturists and farmers in the choice or selection of farm materials for a better yield. From the seed yield determined in (g/m^2) at the Mokwa station showed the highest three values obtained to be 30.0, 18.4 and 18.0, obtained from TVSu – 683, TVSu – 1865 and TVSu – 6 respectively while the least three of the seed yield were 13.0, 10.0 and 7.0 obtained for TVSu – 395, TVSu – 250 and TVSu – 188 respectively. However, the NACGRAB station had the highest three seed yield values (g/m^2) to be 6.90, 4.80 and 4.45 for TVSu – 397, TVSu – 6 and TVSu – 118 respectively, while the least values of 2.01, 1.68 and 1.48 respectively were obtained for TVSu – 186, TVSu – 1277 and TVSu – 193 in that order.

For the number of days to 50% flowering, it was observed at Mokwa thatTVSu – 681, TVSu – 683 and TVSu – 1860 took 55 days, 53 days and 51 days to flower; while TVSu – 8, TVSu – 186 and TVSu – 86 took 39 days, 38 days and 37 days respectively to flower. But at NACGRAB, for the number of days to 50% flowering, TVSu – 681, TVSu – 683 and TVSu – 1860 flowered at 58 days, 55 days and 48 days respectively; while TVSu – 8, TVSu–186 and TVSu – 86 took 40 days, 39 days and 38 days respectively. Moreso, the number of days to maturity at Mokwa showed that TVSu – 115, TVSu – 7 and TVSu – 1 took 136 days, 130 days and 127 days respectively to mature, while TVSu – 395, TVSu – 186 and TVSu – 252 took 112 days, 109 days and 107 days respectively to mature. However, at NACGRAB, the number of days to maturity for TVSu – 1276, TVSu – 86, TVSu – 189, TVSu – 395, TVSu – 1280 and TVSu – 193 were 142 days, 140 days, 139 days, 135 days, 135 days and 125 days respectively.

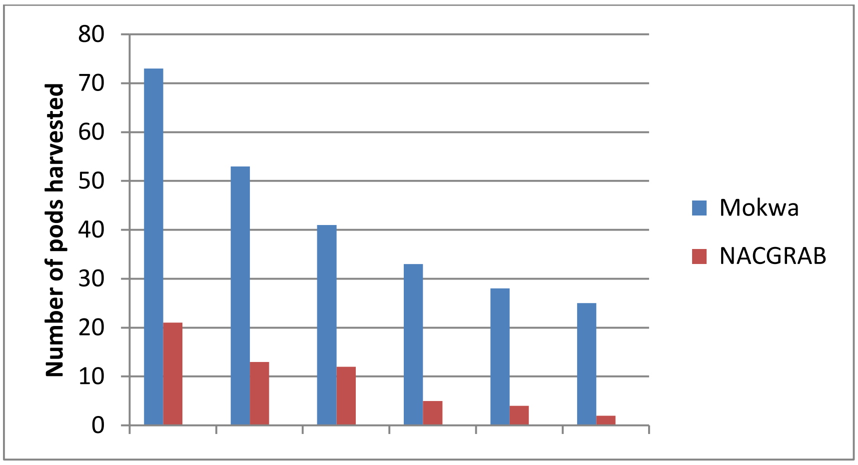

Fig 1: Bar chart showing the highest and the least mean values of number of pods harvested at the 2 locations

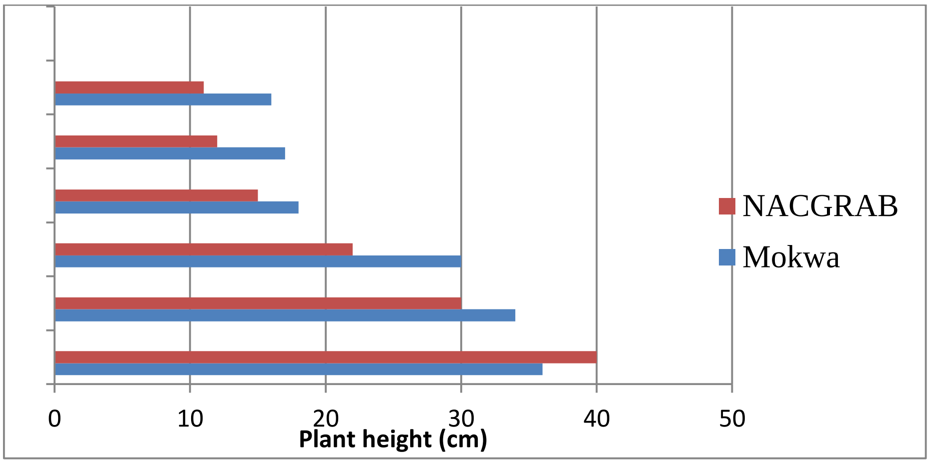

Fig 2: Bar chart showing the highest and the least plantheight (cm) at the 2 locations

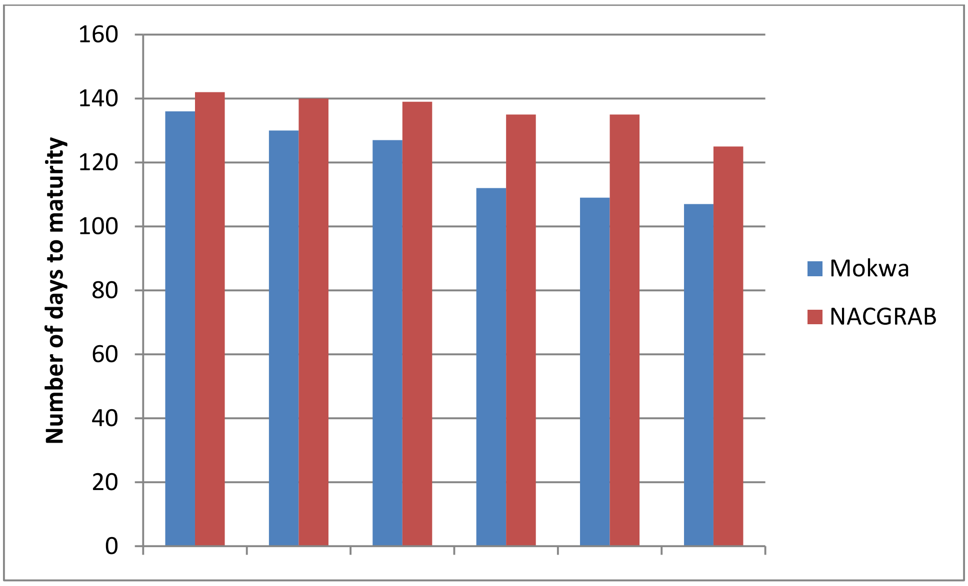

Fig 3: Bar chart showing the highest and the least mean values obtained for the number of days to maturity at the 2 locations

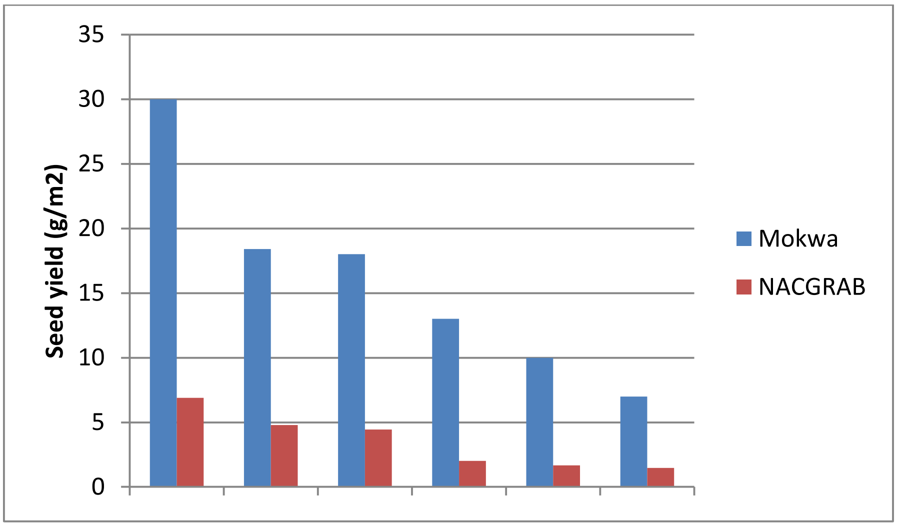

Fig 4: Bar chart showing the highest and the least mean values obtained for seed yield at the 2 locations

DISCUSSION

Thebambara groundnut evaluated for yield and yield variables showed a wide range of variability, this may be due to effect of environment and genetical make-up of the germplasms. Highest mean values for number of pods per plant and seed yield are observed in Mokwa which shows this environment can influence this yield traits more than that of NACGRAB.

It was observed that for number of days to50%flowering, TVSu-8, TVSu-186 andTVSu-86 had the highest mean value cross the two locations. Also for the lowest mean value, TVSu-8, TVSu-186 and TVSu-86 do not differ across the two locations. This shows the environment does not influence the earliness or lateness of these germplasm to mature

Variability occurs among the selected population of Bambara groundnut in the study which can be explored for improved breeding programs and better utilization and conservation.

CONCLUSION

TVSU – 6 (Nigeria), TVSU – 397 (Cameroun), TVSU – 683 (Zambia), and TVSU – 1865 (Zimbabwe) gave the best mean seed yield (18.0, 16.0, 30.0 and 18.4g/m^2) respectively, among these African accessions, across these two agro-ecological zones in Nigeria. There is however need to empower the National Centre for Genetic Resources and Biotechnology (NACGRAB) in Nigeria for improved conservation and utilisation of this legume and other NUS, due to their importance in enhancing food security for the populace at large and especially in Urban areas like Ibadan, Lagos, Kano, Abuja and Jalingo in Nigeria.

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