Agr. Foo. Nat. Res. J. Volume 3, Issue 1, Page 31-36

ISSN: 3043-5420

Agriculture, Food and Natural Resources Journal

The Official Journal of the Faculty of Agriculture, Nnamdi Azikkiwe University, Nigeria

Journal homepage: https://journals.unizik.edu.ng/afnrj

Agriculture, Food & Natural Resources Journal (AFNRJ)

Original Article

Response of different levels of ash and saw dust applications on Bambara Groundnut performance in Ifite-Ogwari, Derived Savannah Zone of Nigeria

OPEN ACCESS

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DOI: https://www.doi.org/10.5281/zenodo.13698213

Editor: *Dr Onyekachi Chukwu, Nnamdi Azikiwe University, NIGERIA*

Received: *February 02, 2024*
Accepted: *March 24, 2024*
Available online: *March 31, 2024*

Peer-review: *Externally peer-reviewed*

Conflict of Interest: *The authors have no conflicts of interest to declare*

Financial Disclosure: *The authors declared that this study has received no financial support*

ABSTRACT

In this study, the response of Bambara groundnut (BGN) in terms of growth and yield to different levels of sawdust was evaluated, a randomized complete block design (RCBD) fitted in to a 2× 4 factorial experiment was conducted at the Training and Research farm of Nnamdi Azikiwe University, Ifite-Ogwari. Two (2) types of soil amendments (sawdust and ash) at four (4) levels of applications including standard (Control, 10 tons/ha, 20 tons/ha, and 30 tons/ha), each replicated three times. Result indicated that, ash treated plots had a greater number of stems, leaf, canopy and biomass while sawdust treated plots had taller plants at 2 weeks after planting (WAP) (9.28cm) and 4WAP (17.44cm) probably due to its excellent mulching effects. Virtually on all the treatments growth and yield parameters, 10kg and 20kg rates the soil amendments were not significantly different except for pod weights. Ash at 20kg rate produced (640kg/ha) which was not significantly different from sawdust(706kg/ha) at the same rate. It is recommend the use of sawdust ash since most sawdust have high carbon / Nitrogen ratio so they tend to mop up soluble soil nutrients which might adversely affect the soil on long run. Although sawdust contain plant nutrients, they are not readily available to the plants until after their decomposition. Therefore, for economic and environmental reasons we recommend the use of 10tons of sawdust ash for the cultivation of Bambara nut in the Research area if available.

KEYWORDS: *Ash. Bambara groundnut. Mulching, Sawdust. Soil amendments,*

INTRODUCTION

Vigna subterranea is commonly known as bambara groundnut and is very popular in African countries. Bambara groundnut is a leguminous plant that develops underground fruits and mainly grown in the arid lands of Africa. The BGN is under the family of *Fabaceae* or *Leguminosae* commonly known as the legume, pea, or bean family, they are a large and agriculturally important family of flowering plants. It includes trees, shrubs, and perennial or annual herbaceous plants, which are easily recognized by their fruit (legume) (Borget, 1992).The BGN is an annual creeping legume with trifoliate glabrous leaves. It has a deep taproot surrounded by numerous lateral roots that contain N-fixing nodules. Flowers appear as papilionaceous racemes. Once

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fertilized, the flower is pulled underground by a tunnel. Fruits are two or three-seeded pods that are 1.5 to 3 cm long, wrinkled, and initially indehiscent. When dry, the seeds are spherical, smooth, and very hard.

Vigna subterranea goes with different common names: (Bambara groundnut, Bambara nut Bambara bean Congo goober earth pea (Food and Agriculture organization, 1994); ground-bean or hog-pean and is a member of the family *Fabaceae*. Its name is derived from the Bambara tribe. (Mubaiwa *et al.,* 2017). The plant originated in West Africa. As a food and source of income, the Bambara groundnut is considered to be the third most important leguminous crop in those African countries where it is grown, after peanut and cowpea. The crop is mainly cultivated, sold and processed by women, and is, thus, particularly valuable for female subsistence farmers. (Azman, 2019). BGN epresents the third most important grain legume in semi-arid Africa. (Ocran, 1998). It is fairly tolerantt to high temperatures and therefore suitable for marginal soils where other leguminous crops cannot be grown (Yamaguchi, 1983) such as arid and semi-arid regions of Africa. It is a low-impact crop (Baryeh, 2001).The entire plant is known for soil improvement because of nitrogen fixation.Vigna subterranea ripens its pods underground, much like the peanut (also called a groundnut). They can be consumed as fresh or boiled after drying, and can be ground either fresh or dry to make products such as puddings (Okpa) apopular product of southeast Nigerian consumers (Oguntunde, 1985)

Vigna subterranea was reported to be originated from several countries of West Africa including Nigeria, Cameroon, Central African Republic and Chad and is cultivated in drier tropical Africa. In Southern Africa, Zimbabwe is the centre of production. It can also be found in tropical parts of America, Asia and Australia, however the present degree of cultivation outside Africa is basically negligible.

Vigna subterranea is adapted to hot, dry, marginal soils, from sea level to an altitude of 2000 m. It continues to grow in harsh conditions better than most crops (sorghum, maize and peanuts). Optimal conditions for growth are 30-35°C day-temperature for germination, average day temperatures ranging from 20 to 28°C under full sun, average annual rainfall of 600-750 mm (optimum yields are obtained when rainfall is higher), good P and K soil content and light sandy loams with a pH of 5.0-6.5 Ayogu,*et al,* .2017, Linnenmann,1994). *Vigna subterranea* can grow in more humid conditions (annual rainfall > 2000 mm), and in every type of soil provided it is well drained and not too calcareous. It is tolerant to drought, to pests and diseases, particularly in hot conditions, (Baudoin and Mergeai,2001; Bultose, *et al*.,2020). In many traditional cropping systems, it is inter-cropped with other root and tuber crops (Brink *et al.,* 2006).The objective of the Research was to demonstrate the use of sawdust and its ash to boost Bambara groundnut production in Ifite-Ogwari a derived Savannah zone of Nigeria.

MATERIALS AND METHODS

Description of Experimental Site

The study was conducted at Faculty of Agriculture Nnamdi Azikiwe University Ifite Ogwari Campus (Lat. 06° 60' 14'' N and long. 6° 95' 02'' E, elevation: 42 MASL) in Ayamelum L.G.A of Anambra state. The hydrology includes floodplains of Omambala River, Ezu River, Du-River and Obina River. The area has a tropical wet-and-dry climate of Koppen’s Aw-type, average annual rainfall of 1700 mm and average mean temperature of 29.0 o C (NIMET, 2022).

Experimental Materials and Experimental Layout

The land race bambara groundnut seeds were obtained from a reputable seed dealer in Awka, Anambra State. The experiment was laid out in a Complete Randomized Block Design (RCBD) and replicated three times. The experimental area covered a total area of 120m². The field layout was designed using randomization to allocate each treatment and their replications to specific plots (beds) without bias.

Cultural Practices

The site vegetation was cleared manually with cutlass. Beds of 1m x 2m with 0.5m walk ways were made. On the whole, 20 plots were used.The seeds were sown at the rate of 2 per hole at 2cm depth and with the plant spacing of 20cm x 30cm

Treatment Application

T0- Control of sawdust ash
T1- 10 tonnes of sawdust ash
T2- 20 tonnes of sawdust ash
Up0 - Control of sawdust
UP1 - 10 tonnes of sawdust
UP2 - 20 tonnes of sawdust.

The sawdust was collected and of which some of the measured amount were burnt and allowed to cure by packing in sacks and kept under shade away from sun and rainfall and covered with polythene sheet for about 3weeks. Each treatment was then applied to the plant at about two weeks after planting.The quantity per bed was based on the calculations above before applying and was applied on the bed areas around each plant.The field was weeded before treatment application.The field was periodically weeded at 2 weeks intervals to avoid weed encroachment on the plants.

Data Collection

Data were collected 2 weeks after planting from the point of 50% emergence. Data were subsequently collected at 2 weeks intervals for 16 weeks. The growth parameters collected include-: days to first germination, germination percentage, plant height, number of leaves, days to first flowering and days to 50% flowering.Yield parameters collected include-: biomass weight, number of pods per plant at harvest,weight of dry pods and seeds, hundred pods and seeds weight, seed yield (kg/ha):

Statistical Analysis

All the data collected were subjected to analysis of variance (ANOVA) and treatment were separated using Genstat Statistical software (Discovery version,2012).

RESULTS AND DISCUSSION

The Influence of the Different Soil Amendments and their Rates on the Soil Chemical Properties.

The soil core samples were collected from horizon A (0-17cm), B (17-33cm), and C (33-54cm) and the tested chemical components were shown on Table 4.1. After the experiment, only horizon A (0-17 cm) was collected due to the rooting pattern of Bambara nut to test the influence of the soil amendments on the soil chemical properties. The Ifite Ogwari soil is naturally acidic, for example the top soil has a pH of 5.50. After the experiment, the control plots (5.80) and sawdust at 20t/ha plots (5.30) were still acidic while sawdust ash at 10t/ha (9.20) and 20t/ha (9.40) were slightly alkaline. The sawdust ash at 10t/ha and sawdust ash at 20t/ha also had slightly higher values (%) of potassium (0.24, 0.21), Calcium (43.3, 27.60) and magnesium (19.2, 17.2) respectively. While sawdust treated plots at 10t/ha 20t/ha had higher values of total nitrogen (0.14, 0.21), available phosphorus (33.5, 35.10), organic carbon (1.07, 3.56) and organic matter (2.87, 6.13). as was recorded in Table 1. This is consonant with the work of Awodum (2007) who stated that sawdust ash treatments applied to soil significantly increased soil and leaf N, P, K, Ca and Mg contents. and numbers of pods, pod weight, number of branches, number of leaves and grain yield**.** The sawdust treated plots at 10t/ha 20t/ha had higher values of total nitrogen (0.14, 0.21), available phosphorus (33.5, 35.10), organic carbon (1.07, 3.56) and organic matter (2.87, 6.13). This is because burning changes some of the nutrients to ash which can be lost easily. It is in line with the work of Obidiebube,*et al*.,2022, Odedina, *et al.*, 2003, who in their work found out that burning change some nutrient to nonmetallic components of organic biomass, therefore the reason for sawdust treated plots having more of the above mentioned components.

Table 1.The Influence of the Different Soil Amendments and their Rates on the Soil Chemical Properties.

Depth(cm)	pH	TN (%)	AP (%)	OC(%)	K (%)	Na (%)	OM (%)	Ca (%)	Mg (%)
Before Treatment									
0 -17	5.50	0.34	0.018	4.71	0.02	0.184	0.09	2.85	1.65
17 - 33	5.10	0.39	0.022	4.55	0.23	0.226	0.19	2.70	1.40
33 – 54	5.10	0.23	0.017	4.18	0.18	0.178	0.43	2.62	1.20
After Treatment									
Control	5.80	0.098	0.050	1.52	0.175	0.072	2.62	4.00	2.00
sawdust Ash	10.80	0.42	0.45	7.8	0.745	0.734	13.44	13.42	4.513
sawdust	7.76	1.19	0.48	3.79	0.308	0.477	53.26	2.41	1.128
S.D Ash-10t/ha	9.20	0.07	15.50	1.4	0.244	0.115	2.43	43.30	19.2
S.D Ash-20t/ha	9.40	0.112	24.70	1.48	0.209	0.102	2.55	27.60	17.2
S. dust-10t/ha	6.20	0.14	33.8	1.67	0.196	0.077	2.87	7.20	2.80
S.dust/20t/ha	5.30	0.21	35.10	3.56	0.343	0.283	6.13	8.00	2.40

pH (Hydrogen potential) TN (Total Nitrogen), AP (Available Phosphorus), OC (Organic Carbon), K (Potassium), Na (Sodium), OM (Organic Matter), Ca (Calcium), Mg (Magnesium)

Response of Different Sawdust and Ash Rates to Bambara Groundnut Growth Parameters.

At 2WAP, ash treated plots had a higher number of stems (22.1) than sawdust treated plots (16.1) while 10kg and 20kg rates did not significantly vary, they performed better than control (15.2). the treatments interactions showed that 20kg sawdust(10.33cm) produced the tallest plants (10.33cm) followed by 10kg sawdust (8.93cm) though not significantly different from 20kg Ash (8.33cm). The least still came from the controls. On leaf numbers, ash treated plants (69.2) had the largest leaf number followed by sawdust treated plots (48.3). This is in line with the findings of Owolabi, *et al* 2003 who opined that ash contains 1.16%N, 0.04%P, 2.8% K, Mg 0.07% and Ca 0.035% in soluble forms that are usable by the plants. In their research ash increased yield of cowpea okra and tomato. Ash serves as liming and fertilizer materials. Since most southern Nigeria soils are slightly acidic, liming helps to improve the soils physical condition (Ojeniyi *et al*, 2003).

Table 2: Response of different Sawdust and Ash Rates to Bambara Groundnut Growth Parameters.

TREAT MENTS	2 WAP			4 WAP		6 WAP			8WAP	
	No of stems	Height	Leaf No.	Height	Canopy	Canopy	No of Stems	Canopy	No of Stems	Canopy
sawdust	16.1	9.28	48.3	17.44	41.43	38.3	30.7	21.00	23..8	21.1
Ash	22.1	7.18	69.2	13.61	39.48	40.5	31	17.36	24.3	31.9
Lsd	4.65	1.27	13.90	2.72	3.38	4.78	6.11	4.15	5.29	7.33
0kg	15.2	6.92	46.0	15.83	40.50	40.5	19	19.58	23.8	26.0
10kg	20.8	8.33	62.5	15.58	40.32	37.4	32.5	18.45	22.0	24.2
20kg	21.3	9.43	67.8	15.17	40.55	40.4	41	19.50	26.3	29.3
Lsd	5.70	1.56	17.02	3.33	4.14	5.86	7.48	5.08	6.48	8.98

Interactions of Different Sawdust and Ash Rates to Bambara Groundnut Growth Parameters.

The treatments interactions in Table 3 affected number of stems 20kg sawdust (46) produced the largest numbers of stems but not different from 10kg and 20kg Ash. At 8 WAP, the treatments type and rates had no effect on the crop canopy, but the interactions 20kg Ash (35.3) was the largest and significantly the same with 0kg ash and 10kg Ash. The insignificant difference in Bambara groundnut growth parameters and non effect of the interaction can be attributed to low soil fertility status which is in line with the studies of Nkala *et al*., (2018), which stated that inadequate soil fertility negatively affects the vegetative and reproductive growth stages of Bambara groundnut, leading to reduced biomass accumulation.

T**able 3.: Interactions of Different Sawdust and Ash Rates to Bambara Groundnut Growth Parameters.**

Treatment	**2 WAP**			**4 WAP**		**6 WAP**			**8WAP**	
interactions	No of stems	Height	Leaf No.	Height	Canopy	Canopy	No of stems	Canopy	No of stems	Canopy
sawdust + 0kg	15.7	8.57	47.0	15.33	40.40	37.3	15.7	20.67	22.0	20.6
sawdust + 10kg	16.3	8.93	49.0	17.67	43.50	37.3	30.3	19.67	19.7	19.4
sawdust + 20kg	16.3	10.33	49.0	19.33	40.40	40.4	46.0	22.67	29.7	23.3
Ash + 0kg	14.7	5.27	45.0	16.33	40.60	43.6	22.3	18.50	25.7	31.4
Ash + 10kg	25.3	7.73	76.0	13.50	37.13	37.4	34.7	17.23	24.3	29.0
Ash + 20kg	26.3	8.33	86.7	11.00	40.4	40.4	36.0	16.33	23.0	35.3
Lsd	8.05	2.21	24.07	4.71	5.88	8.28	10.58	7.19	9.17	12.70

Response of Different Sawdust and Ash Rates to Bambara Groundnut Yield Parameters

The treatments in Table 4 had no different effect on pod weight while 20kg rates were significantly higher (16.83g) than 0kg and 10kg, 20kg sawdust (17.67g) and 20kg Ash (16.00g) performed better than other treatments combinations. The above ground fresh biomass weight was higher in Ash (37.9g) than sawdust (24.8g) while 10kg rates (31.3g) did not vary from 20kg rates (37.2g) as recorded in Table 4. The findings here agrees with the research of Awodum (2007), who commented that sawdust ash treatments applied to soil significantly increased numbers of pods, pod weight and grain yield

Table 4. Response of Different Sawdust and Ash Rates to Bambara Groundnut Yield Parameters

TREATMENTS	Pod weight (g)	Biomass Fresh weight (g)	Biomass Fresh weight (g)	Pod yield per Hectare (kg/ha)
sawdust	11.78	24.80	18.20	471.2
Ash	11.44	37.90	10.00	457.5
Lsd	3.08	9.22	4.82	123.2
0kg	9.50	25.50	9.70	380
10kg	8.50	31.30	14.50	340
20kg	16.83	37.20	18.20	673.2
Lsd	3.77	11.79	5.91	151

Interactions of Different Sawdust and Ash Rates to Bambara Groundnut Yield Parameters

On treatments interactions, (Table 5) 10kg Ash (39.7g) and 20kg Ash (39.3g) produced the highest fresh biomass which were the same and significantly higher than sawdust 0kg (16.3g). sawdust rate at 20kg/ha produced the highest fresh pod weight per hectare (706kg/ha) but was significantly the same with Ash 640(kg/ha) at the same rate.The interaction result on yield here disagrees with the work of Owolabi, *et al., (*2003) who opined that burning releases metallic minerals from organic materials making available for immediate plant use.

Table 5. Interactions of Different Sawdust and Ash Rates to Bambara Groundnut Yield Parameters

Treatment interactions	Pod weight (g)	Biomass Fresh weight (g)	Biomass Fresh weight (g)	Pod yield per Hectare (kg/ha)
sawdust + 0kg	8.67	16.30	10.30	347
sawdust + 10kg	9.00	23.00	20.30	360
sawdust + 20kg	17.67	35.00	24.00	706.8
Ash + 0kg	10.33	34.70	9.00	413.2
Ash + 10kg	8.00	39.70	8.70	320
Ash + 20kg	16.00	39.30	12.30	640
Lsd	5.33	15.97	8.35	213.2

CONCLUSION AND RECOMMENDATION

In conclusion, the sawdust ash applied as soil amendment had positive effect on the soil of Ifite Ogwari which is naturally acidic and because of this, the soils were slightly alkaline after amendment. This can be attributed to the neutralizing effect of ash which acts as liming material. On treatment types effects on the crops, ash treated plots had more number of stems, lead number, canopy and biomass. Although sawdust contain plant nutrients, they are not readily available to the plants until after their decomposition. So for economic reasons we recommend the use of 10 tons of Ash for the cultivation of Bambara groundnut in the area.

Acknowledgements: We acknowledge all the authors for each persons contribution in one way or the other from the

proposal, field, laboratory work and in preparation of the manuscript.

Authors Contribution:

Author EAO supervised the work in the field, HO prepared the manuscript, CCO did the analysis, author SOM proof read the work while CME and GCA managed data in the field and did some errand.

Ethics Committee Approval: N/A.

REFERENCES

Abiodun, F. O., Isola, J. O., & Smart, M. O. (2022). Influence of Sawdust Mulch on Soil Properties, Growth and Yield Performance of Okra abelmoschus esculentus (l.) Moench in an alfisol. FUTY Journal of the Environment Vol. 16 No. 3. Pp 12 - 22

Awodum, M. A, (2007). Effects of Sawdust Ash on Nutrient Status, Growth and Yield of Cowpea (*Vigna uunguiculata* L. Walp). *Asian Journal of Agricultural Research*,Vol I (2): 92-96. https://www.doi.org/10.3923/ajar.2007.92.96

Ayogu R, Edeh R, Madukwe E, & Ene-Obong, H. (2017) Commonly consumed foods: nutritional quality and contributions to recommended nutrient intakes of schoolchildren in rural southeastern Nigeria. Food Nutr Bull. (2017) 38:65–77. https://www.doi.org/10.1177/0379572116689627

Azman, H. R., Barkla, B. J., Mayes, S., & King, G. J. (2019). "The potential of the underutilized pulse bambara groundnut (*Vigna subterranea* (L.) Verdc.) for nutritional food security". Journal of Food Composition and Analysis. 77: 47–59. https://www.doi.org/10.1016/j.jfca.2018.12.008

Baryeh, E.A. (2001). "Physical properties of bambara groundnuts". Journal of Food Engineering. 47 (4): 321–326. https://www.doi.org/10.1016/s0260-8774(00)00136-9

Baudoin, J.P. & Mergeai, G. (2001). Grain Legumes. In: Raemaeker, R., Ed., Crop Production in Tropical Africa, Directorate Generale for International Cooperation, Brussels. Journal A - Z. Pp 313-317

Borget, M. (2006). Food Legumes. In: The Tropical Agriculturalist, CTA Macmillan. Lost Crops of Africa. Vol. II: Vegetables. Washington, DC: The National Academies Press. 2006. p. 53. https://www.doi.org/10.17226/11763

Ecocrop. FAO (2011). https://ecocrop.review.fao.org/ecocrop/srv/en/about

Linneman, A. R. & Craufurd P. Q. (1994). Effects of temperature and photoperiod on phonological development in three genotypes of Bambara groundnut (*Vigna subterranea*). Annals of Botany 74:675-681.

MOFA, (2015). National Seed Policy on Ghana (Seed Management Manual for Ghana). https://faolex.fao.org/docs/pdf/gha170416.pdf

Mubaiwa J, Fogliano, V, Chidewe, C, Jan, B. E, & Linnemann A.R. (2018). Utilization of bambara groundnut (*Vigna subterranea* (L.) Verdc.) for sustainable food and nutrition security in semi-arid regions of Zimbabwe. 13:e0204817tt. https://www.doi.org/10.1371/journal.pone.0204817

Mubaiwa, J., Fogliano, V.; Chidewe, C. & Linnemann, A. R. (2017). "Hard-to-cook phenomenon in bambara groundnut (*Vigna subterranea* (L.) Verdc.) Processing: Options to improve its role in providing food security". Food Reviews International. 33 (2): 167–194. https://www.doi.org/10.1080/87559129.2016.1149864

Nigeria Meteorological Agency Nigeria (NIMET) (2022). Climate Weather and Water Information for sustainable development and safety,. Climate and Health Bulletin Pp 1-15

Obidiebube, E. A., Okolie, H., Obasi, C. C. & Ochuenwike, K..L. (2022). Effects of Different Rates of Wood Ash on the Growth and Yield of Carrot (Daucus Carota) in Awka, South Eastern Nigeria. Current Research in Agricultural Sciences 9 (1), 13-21

Odedina, S.A., Odedina, J. N., Ayeni, S. O., Arowofolu, S. A., Adeyeye S. D., & Ojeniyi, S. O. (2003). Effects of types of ash on soil fertility nutrient availability and yield of tomato and pepper. Nigeria. Journal of Soil Science, 13:61-67.

Oguntunde, A.O, (1985).“Development of new food products from readily available raw materials,” in Proceedings of the Nigerian Institute of Food Science and Technology Training Workshop, Ibadan, Nigeria. Pp 150 - 157 http://www.bioline.org.br/pdf?nf07036