E-ISSN: 2346-7290

Evaluation of the performance of yam (*Dioscorea sp)* on different soil types in Kabba, Nigeria

[1]Babalola, T.S.*, [2]Fasina, A.S., [2]Ogunleye, K.S., [1]Abadunmi, T. and [1]Ayodele, F.G.

[1]Kabba College of Agriculture, Division of Agricultural Colleges, Ahmadu Bello University, PMB 205, Kabba, Kogi State, Nigeria.

[2]Department of Soil and land Management, Federal University, Oye-Ekiti, Ekiti State, Nigeria.

*corresponding author (Email: drbabalolatemitopeseun@gmail.com; Phone: +2347030547750)

ABSTRACT

This study was carried out to evaluate the performance of yam on gambari iron pan, gambari concretional and adio soil types of Kabba College of Agriculture, Kogi State in the Southern Guinea Savannah of Nigeria. It consists of qualitative and quantitative evaluation. The qualitative aspect involves land suitability evaluation (LSE) of the soil types for yam with parametric method of LSE while the quantitative involves the evaluation of the growth and yield performance of yam on the soil types. The experiment on growth and yield performance was laid out in a Randomized Complete Block Design (RCBD). Data were collected on growth and yield characters of yam, subjected to analysis of variance and means were separated using Duncan multiple range test. LSE showed that adio soil is actually moderately suitable (S2) and potentially highly suitable (S2) for yam production with index of actual productivity (IPC) of 68.00 and index of potential suitability of (IPP) 85.00. Tuber weight, vine of leaves and vine length were significantly different ($P < 0.05$) with yam planted on adio soils having the highest values for all the growth and yield parameters studied. The use of adio soil types for yam cultivation is recommended.

Keywords: Soil, suitability, qualitative, quantitative, yam

INTRODUCTION

Yam is among major cash and most consumed food crops in West African countries (Gaztambide, and Cibes, 1975; Babaleye, 2003). Its cultivation is very profitable despite high costs of production and price fluctuations in the markets (IITA, 2013a; Izekor and Olumese, 2010). An average profit per yam seed, harvest and storage in Nigeria was calculated at over US$13, 000 per hectare harvested (IITA, 2013b). Households demand for yam consumption is very high in Sub-Saharan Africa. Nutritionally, yam is a major staple food consumption, providing food for millions of people in the West Africa. It is eaten in different forms such as fufu (the so-called poundo yam and Amala in Nigeria), boiled, fried and roasted (Adioo, 2009; IITA, 2009).

Despite the importance of yam to people, the attention to its production is still questionable (Verter and Bečvařova, 2014). Some researchers have empirically investigated factors that determine the level of yam production in Nigeria and elsewhere in the world. Bamire and Amujoyegbe

(2005) find a positive relationship between net returns (profitability) in yam output and land improvement techniques in Nigeria. In the views of Ayanwuyi *et al*. (2011), soil fertility factor is also constraint to yam production.

Soils in most landscapes form the foundation for many ecological processes such as biogeochemical cycling, distribution of plant communities and, ultimately, the location of human activities. Most soil studies, often characterize the soil to garner about its inherent/dynamic properties. Soils are usually characterized using relevant physical, chemical and morphological properties inherent in them. It has been reported by Idoga *et al.* (2006) that soil as a natural resource cannot be properly managed without proper understanding of their characteristics. Soil classification and characterization systems organize soil variability into useful groupings that can be identified by field investigation and documented in soil survey activities to promote effective resource management and technology transfer. It involved qualitative suitability evaluation carried out by merging of soil properties with plant requirement in other to establish the extent of suitability of the soils for specific crops and qualitative suitability evaluation involving evaluation of crop performance.

Most past studies on suitability assessments focused only on the qualitative aspect (Oluwatosin and Obatolu, 2005; Husseni, 2011; Nuga and Akinbola, 2015; Adeyolanu *et al.*, 2017). This in most times may not be readily useful to the end user, in that they are more interested in the crop yields (Fasina *et al.*, 2008). Therefore, there is need for quantitative suitability evaluation of crops in soils to accompany the qualitative suitability assessment in other to evolve the best management strategies for sustainable and optimum productivity.

The objective of this study is to evaluate the suitability of yam in three soil types of Kabba College of Agriculture, Kabba, Kogi State, Nigeria.

MATERIALS AND METHODS

Experiment site: The study was carried out at Kabba College of Agriculture on latitude 7˚85′47″N and longitude 6˚08′02″E. The area is within the southern Guinea Savanna agro-ecological zone of Nigeria with rainfall that spans the month of April, early May to November. The average annual rainfall is 1,329mm, mean annual temperature of the area is 30^{o}C and mean annual relative humidity is 67% (Weather base, 2019).

Experimental design and treatments: Field experiments was arranged in a randomized complete block design (RCBD) comprising of three soils series identified by Babalola (2018) which formed the treatments. They are named: gambari iron pan, gambari, concretional and Adio. The treatments were replicated ten times.

Table1: Soil classification of the area

USDA Classification	FAO/WRB Classification	Series Classification
Typic durustalfs	Petroplinthic Lixisols	Gambari iron pan
Typic Kandiustalfs	Ferric Lixsols	Gambari very concretional
Aquic Arenic Kandiustalfs	Gleyic Lixisols	Adio

Source: Babalola (2018)

USDA= United States Department for Agriculture, FAO= Food and Agricultural Organization, WRB= World Reference Bas

Cultural Practices: The land was slashed and packed; heaps were made at 1m by 1m spacing. Yam sett of the same weight were made and planted at one sett per heap. Mulching was done at four months after planting with plant residues while staking was done as soon as the yam vines emerged. Weeding was done regularly by hoeing when weeds are noticed to prevent competitions for nutrients and space. Fertilizer was applied based on blanket recommendation of FFD (2002). The tubers were harvested when mature with hoe and cutlass.

Data collection

a. Vine length (cm)was measured with measuring tape
b. Number of leaves was measured by counting at two-week interval.
c. Stem girth at 30 cm from the base of the plant (cm) was measured with Vernier-caliper.
d. Individual tuber weight (kg) was measured with weighing scale.
e. Tuber length (cm) was measured with measuring tape.
f. Tuber diameter (cm) was measured with Vernier-caliper.

Data analysis: Growth and yield data were subjected to analysis of variance and where significant differences were observed; the means were separated using Duncan Multiple Range Test (DMRT). All tests were carried out at 5% probability level with Statistix software version 10.

The suitability of the soils for yam was evaluated with parametric method of land suitability evaluation (Ogunkule, 1993). Five land quality groups: climate (t), topography (t), soil physical properties (s), wetness (w) and fertility (f) were used for the evaluation. (Table 2 and 3) Only one member in each group was used for calculation purpose because there are usually strong correlations among members of the same group (Ogunkunle, 1993). For actual (current) productivity index (IPC) all the lowest characteristics rating for each land quality group were used in the index of productivity equation.

Table 2: Land requirements of suitability classes for yam (Modified from Sys, 1985)

Land Qualities	S1 100 – 95	S2 94-85	S3 84-40	N 39 - 20
Climate (c)				
Annual rainfall (mm)	> 800	600-800	500-600	< 500
Mean annual temperate (°C)	25-30	20-25	20	20-30
Topography (t)				
Slope (%)	0-4	4-8	8-16	>16
Soil drainage	Well	Moderate	Imperfect	Poor
Soil physical characteristics (s)				
Soil texture	L, SL SiL, SCL	SiC,SiCL Cl, SC	LS LCS, FS	CS, S
Soil depth (cm)	> 70	50 -70	35-50	< 35
Soil Fertility (f)				
Total N (%)	> 0.20	0.20- 0.15	0.10- 0.15	< 0.10
Exchangeable K	> 0.6	0.3-0.6	0.3-0.2	< 0.2
Ph	6.1-7.5	5.6-6.0	4.5-5.5	7.6-9.0 > 9.0 < 4.5
ECEC clay (Cmol/kg)	> 40	40-16	16-12	< 12
Base Saturation (%)	> 35	35-20	20	< 20

L= loam, SL= sandy loam, SiL= silty loam, SCL = sandy clay loam, SiC= silty clay, SICL = silty clay loam, CL= clay loam, SC= sandy clay LS= loamy sand, LCS= loamy clay sand, FS= fine sand, CS= coarse sand, S= sand, N= nitrogen, K= potassium, ECEC= effective cation exchange capacity

Table 3: Land characteristics of the study location

Land qualities	Gambari iron pan	Gambari concretional	Adio
Climate (c)			
Annual rainfall (mm)	1,329	1,329	1,329
Mean annual temperature (°c)	30	30	30
Topography (t)			
Slope (%)	2.1	1.8	1.1
Wetness (w)			
Soil drainage	Imperfect	Imperfect	moderate
Soil physical characteristics (s)			
Soil texture	SCL	SCL	SL
Soil depth (cm)	40	150	150
Soil fertility (f)			
Total N (%)	0.25	0.22	0.30
Exchangeable K (cmol/kg)	0.38	0.39	0.46
pH	6.40	6.39	5.72
ECEC clay (cmol/kg)	11.40	7.68	15.72
Base saturation (%)	80.25	86.68	91.58

Source: Babalola (2018)

SCL = sand clay loam, N= nitrogen, K= potassium, ECEC= effective cation exchange capacity

RESULTS

Suitability evaluation for yam: The result of land suitability evaluation ratings of soil types for yam is presented in Table 4. The actual suitability rating is the suitability of the soils in its present condition when the correctable limitations (fertility) are considered in the evaluation. Gambari iron pan and gambari concretional soil types have index of actual productivity (IPC) of 14.62 and 14.25, they are therefore rated actually not suitable for yam production. The adio soil type has IPC of 68.00 and was rated moderately suitable for yam.

The potential suitability is the suitability of the soils when the correctable limitations (fertility) are not considered in the evaluation. The index of potential suitability (IPP) of 50.40 and 51.00 ratings were recorded for gambari iron pan and gambari concretional and they were rated marginally suitable. Adio soil type was highly suitable with IPP of 85.00.

Table 4: Suitability class scores of the soil types for yam

Land qualities	Gambari iron pan	Gambari concretional	Adio
Climate (c)			
Annual rainfall (mm)	S1 (100)	S1 (100)	S1 (100)
Mean annual temperature (^{0}c)	S1 (100)	S1 (100)	S1 (100)
Topography (t)			
Slope	S1 (100)	S1 (100)	S1 (100)
Wetness (w)			
Soil drainage	S3 (60)	S3 (60)	S3 (60)
Soil physical characteristics (s)			
Soil texture	S1 (95)	S1 (95)	S1 (95)
Soil depth	S3 (84)	S1 (100)	S1 (100)
Soil fertility (f)			
Total N	S1 (100)	S1 (100)	S1 (100)
Exchangeable K	S2 (85)	S2 (85)	S2 (85)
pH	S1 (100)	S1 (100)	S1 (100)
ECEC	N (29)	N (25)	S3 (80)
Base saturation	S1 (100)	S1 (100)	S1 (100)
Actual	14.62 (N)	14.25 (N)	68.00 (S2)
Potential	50.40 (S3)	51.00 (S3)	85.00 (S1)

S1= highly suitable, S2= moderately suitable, S3= marginally suitable, N= not suitable
N= nitrogen, K= potassium, ECEC= effective cation exchange capacity

Performance of yam on the soil types: Results of the growth and yield performance of yam are presented in Tables 5-8. There was significant difference ($P < 0.05$) in the number of leaves. Yams on adio soil types has significantly higher value of 5.800, 63.600, 115.00, 146.20, 168.60 and 196.60 at 26, 28, 30, 32, 34, 36 and 38 weeks after planting (WAP) respectively (Table 5). There was no significant difference in the value recorded for gambari iron pan and gambari concretional.

Table 5: Number of Leaves of yam

Treatments	26WAP	28WAP	30WAP	32WAP	34WAP	36WAP	38WAP
Gambari Iron pan	0.0000[b]	11.000[b]	59.40[b]	98.40[b]	117.20[b]	156.00[b]	156.00[b]
Gambri concretional	1.2000[b]	11.600[b]	41.00[b]	72.20[b]	109.00[b]	166.20[ab]	177.60[ab]
Adio	5.8000[a]	63.600[a]	115.00[a]	146.20[a]	168.60[a]	196.60[a]	196.60[a]

Means with different alphabets are significant at 0.05 level of probability while means with the same alphabets are not significant.
WAP=weeks after planting

There was significant difference (P < 0.05) in the vine length. Yams planted on adio soil type had significantly higher value of 295, 316.60, 334.00, 376.00, 437.40 and 438.00 cm at 28, 30, 32, 34 and 38 WAP respectively (Table 6). Gambari iron pan had the highest value of 42.800cm at 26 WAP.

Table 6: Vine Length of yam (cm)

Treatments	26WAP	28WAP	30WAP	32WAP	34WAP	36WAP	38WAP
Gambari Iron pan	42.800[a]	151.40[b]	243.80 [ab]	284.40[b]	315.00[b]	336.00[ab]	336.00[b]
Gambri concretional	36.400[a]	154.60[b]	197.80[b]	283.40[b]	310.00[b]	257.80[ab]	341.20[b]
Adio	38.600[a]	295.00[a]	315.60[a]	334.00[a]	376.00[a]	437.40[a]	438.00[a]

Means with different alphabets are significant at 0.05 level of probability while means with the same alphabets are not significant.
WAP=weeks after planting

There was no significant difference (P < 0.05) in the stem girth. However, the yam planted on gambari iron pan had higher values of 2.8200, 3.6800, 3.8000 and 3.9800 cm at 28, 34, 36, and 38 WAP respectively (Table 7). At 30 and 32 WAP gambari concretional had the highest values of 3.2400 and 3.4200 cm respectively.

Table 7: Stem Girth of yam (cm)

Treatments	28WAP	30WAP	32WAP	34WAP	36WAP	38WAP
Gambari iron pan	2.8200[a]	2.9000[a]	3.3200[a]	3.6800[a]	3.8000[a]	3.9800[a]
Gambari concretional	2.6000[a]	3.2400[a]	3.4200[a]	3.5400[a]	3.5800[a]	3.7800[a]
Adio	2.3000[a]	2.5200[a]	3.2000a	3.4600[a]	3.6600a	3.8200[a]

Means with different alphabets are significant at 0.05 level of probability while means with the same alphabets are not significant.
WAP=weeks after planting

There was significant difference in the tuber weight. Yam planted on adio soil type had the highest value of 1.9378kg (Table 8). There was no significant difference (P<0.05) in the tuber diameter and tuber length although, yams planted on the adio soil type had the highest value of 16.380 and 27.280cm respectively.

Table 8: Tuber parameters of yam

Treatments	Tuber diameter (cm)	Tuber weight (kg)	Tuber length (cm)
Gambari Iron pan	15.940[a]	1.1618[b]	25.980[a]
Gambri Concretional	16.300[a]	1.1530[b]	25.340[a]
Adio	16.380[a]	1.9378[a]	27.280[a]

Means with different alphabets are significant at 0.05 level of probability while means with the same alphabets are not significant.
WAP=weeks after planting

DISCUSSION

The land suitability evaluation of all the soil types are below class S1 (highly suitable as a result of wetness (moderate to imperfect drainage), soil physical characteristic (soil depth of 40cm for gambari iron pan) and soil fertility (Exchangeable K, pH and ECEC clay). The fertility limitation can be corrected with appropriate soil management practices. This will improve the suitability ratings of the soil and was revealed in the higher suitability ratings of the soil types for yam.

Adio soil types had the best actual and potential suitability ratings, and significantly higher number of leaves, vine length and tuber weight. This is in addition to highest values for tuber diameter and length. The better performance of yam on Adio soil type can be attributed to the better fertility status of the soil which is reflected in the higher Total nitrogen, Exchangeable potassium, Effective cation exchange capacity and base saturation values of the soil type. The values indicated that the soil types have higher ability to hold and exchange nutrient than others. Ayanwuyi *et al*. (2011), Eruola (2012) and Diby *et al*. (2009) all stressed the importance of soil fertility in yam production.

O' Sivillian and Ernest (2008) submitted that decline in yam yield under continues cultivation is as a result of decline in the level of natural soil fertility. Carsky *et al*. (2010) identified N as one of the most limiting nutrients for yam growth.

Marschner (1995) reveal that K is also an important nutrient in yam production.

CONCLUSION

The land factors limitation to yam production in the soils studied are soil drainage, soil depth, exchangeable K and ECEC. Exchangeable K and ECEC are fertility limitations that can be altered with good soil management.

The gambari iron pan and gambari concretional soils are actually not suitable but with proper soil management of the fertility limitations will be potentially marginally suitable for yam production. The adio soil type was actually moderately suitable and potentially highly suitable for yam production. Optimum yam yield will be achieved in the adio soil types than the other soils studied in the area, therefore, the soil type should be considered mostly for yam production in the study location. Quantitative evaluation of soils for crops should be a component of land suitability evaluation studies.

REFERENCES

Adeyolanu, O. D., Are, K. S., Adelana, A. O., Denton, O. A. and Oluwatosin, G. A. 2017. Characterization, suitability evaluation and soil quality assessment of three soils ofsedimentary formation for sustainable crop production. *Journal of Agriculture andEcology Research International*, 11(2), 1-10.

Adioo, R. 2009. *An analysis of yam consumption pattern in Ghanaian urban communities*. Ph.D. Dissertation. Kumasi, Ghana, Department of Agricultural Economics, Agribusiness and Extension, *KNUST*.

Ayanwuyi, E., Akinboye, A. O. and Oyetoro, J. O. 2011. Yam production in Orire local government area of Oyo State, Nigeria: farmers perceived constraints. *World Journal of Young Researchers*, 1(2), 16-19.

Babalola.T.S, 2018. *Pedogensis of soils derived from different parent materials in two Agro ecological zones of Nigeria* (Unpolished) PhD. Thesis, Ekiti State University, Nigeria. 288pp.

Babaleye, T. 2003. West Africa: Improving yam production technology. *ANB-BIA*, 463, 56-59.

Bamire, A. S. and Amujoyegbe, B. J. 2005. Economic analysis of land improvement techniques in small holder yam based production system in the agro-ecological zones of Southwestern Nigeria. *Journal of Human Ecology*, 18(1), 1-12.

Carsky, R.S, Aseidu R.and Cornet, D. (2010). Review of soil fertility management for yam based systems in West Africa, A Research Article in *AJRTC*, 8(2), 1-17

Diby L.N, Hgaza V.K, Tie B.T, Assa.A, Carsky, R. and Girardin, O. 2009. Productivity of yams (*Dioscorea spp*) as attended by soil fertility. *J. Anim. plant science*, 5, 494-506.

Eruola, A, O. Bello, N.J. Ufoegbune, G.C, and Makinde A.A 2012. Effect of variety selection of growth, development and yield of white yam in south western Nigeria. *International Journal of Agriculture and forestry*, 2(3), 101-104.

FFD (Federal Fertilizer Department) 2002. Fertilizer use and management practices for crops in Nigeria. Chude, V.O., Olayiwole, S.O., Osho, A.O. and Daudu, C.K (eds). Federal Ministry of Agriculture and Rural Development, Abuja. 188pp.

Gaztambide, S. and Cibes, H.R 1975 Nutritional deficiencies of yams (*Dioscorea spp*) and related effects on yield and leaf composition the *Journal of Agriculture of the University of Puerto Rico,* 54(4), 264-273.

Hussaini, G.M. 2011. *Land suitability evaluation for some selected land use type in the Institute for Agricultural Research farm,* Zaria, Nigeria. Unpublished M.Sc. Thesis. Department of Soil Science, ABU, Zaria .

Idoga, S., Ibanga, I.J. and Malgwi, W.B. 2006. Variation in Soil morphological and physical properties and their management implications on a toposequence in Samaru area, Nigeria. pp. 19-25. In Proceedings of the 31st Annual Conference of Soil Science Society of Nigeria. Ahmadu Bello University, Zaria, Nigeria. November 13-17 2006. 176-179.

IITA (International Institute for Tropical Agriculture) 2009. Yam (*Dioscorea* species). Available at: http://www.iita. org/yam. [Accessed: 15, March 2019].

IITA (International Institute of Tropical Agriculture) 2013a. Healthy yam seed production. IITA Publications. Retrieved from IITA Website http:// www.iita.org/publications.

IITA (International Institute of Tropical Agriculture) 2013b. Report, achievement, challenges and prospects of yam production in Nigeria, IITA, Ibadan, Nigeria.

Izekor, O. B. and Olumese, M. I. 2010. Determinants of yam production and profitability in Edo State, Nigeria. *African Journal of General Agriculture*, 6(4), 205–21.

Marschner H. 1995. Mineral nutrition of higher plants. London Academic Press.

Nuga, B.B. and Akinbola, G.E. 2015. Land suitability evaluation of soils on two mapping units for Some arable crops in South Eastern Nigeria. *IOSR Journal of Agriculture and Veterinary Science,* 8(3), 66-73.

Ogunkunle, A.O. 1993. Soil in land suitability evaluation: an example with oil palm in Nigeria. *Soil Use and Management,* 9(1), 35-40.

Oluwatosin, G.A. and Obatolu, C.O. 2005. Climate in land evaluation: An experience with land suitability for cocoa cultivation in Nigeria. *Journal of Sustainable Agriculture and the Environment*, 7(1), 113– 128.

O'Suvllivian J.N. and Ernest J. 2008. Root distribution of yam (*Dioscorea alata*) determined by strontium tracer. *Experimental Agriculture,* 44(2), 223-233.

Sys C. 1985. Land Evaluation, Part I-III. 247p Publication No 7 of the General Administration of Cooperative Development. *Place de champs de Mars* 5, *biote* 57, 1050 Bruxelles

Verter, N. and Bečvařova, V. 2014. Yam production as pillar of food security in Logo Local Government Area of Benue State, Nigeria. *European Scientific Journal*, 10(31), 27–42.

Weatherbase 2019. Weather averages summary. http://www.weatherbase.com/weather/weather.php3?s=603696&cityname 3rd June, 2019.