ASSESSMENT OF THE PRODUCTIVITY OF SWEET POTATO VARIETIES GROWN ON SOIL AMENDED WITH PRUNINGS OFAGRO-FORESTRY TREE SPECIES IN SOUTH EASTERN NIGERIA

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ABSTRACT

The agronomic effectiveness and economic viability of soil amendment with prunings of agro-forestry tree species in sweet potato production on a highly weathered soil of South Eastern Nigeria were assessed in a field study conducted in 2010 and 2011 at the research farm of the National Root Crops Research Institute, Umudike, Abia State, Nigeria. Treatment comprised prunings of three agro-forestry tree species (*Dactyladenia barterii, Gliricidia sepium* and *Chloropenthra microphylla*) in factorial combinations with three sweet potato varieties (Ex-Igbariam, TIS 87/0087 and TIS 2532.OP.113) arranged in a randomized complete block design with three replications. Optimum NPK fertilizer recommendation for sweet potato production in South Eastern Nigeria and a plot having neither the agro-forestry tree pruning nor inorganic NPK fertilizer amendment were included as checks. Results showed that Soil amendment with prunings of agro-forestry trees resulted in variable increases in such soil chemical properties as total N, total organic carbon, exchangeable K, available P and pH relative to absolute control. Such increases in soil chemical properties following application of the treatment were highest in optimum NPK fertilizer control treatment. Also, total root yield production potentials of sweet potato were enhanced following soil amendment with either agro-forestry tree prunings or optimum NPK fertilizer treatment compared to when there was no amendment. Similarly, application of the treatments resulted in the production of higher number of saleable roots and lower number of un-saleable roots relative to the un-amended control. Amending the soil with prunings of *G. sepium* gave the highest return per Naira invested followed by *C. microphylla* and optimum NPK fertilizer. With the exception of *D. barterii* pruning, soil amendment with *G. sepium, C. microphylla* prunings or optimum NPK fertilizer proved to be more economically beneficial for sweet potato production on the highly weathered soil of South Eastern Nigeria than the absolute control.

Keywords: Productivity, agro-forestry tree pruning, sweet potato and soil amendment

INTRODUCTION

In many countries of Sub-Saharan Africa, nutrient removal through harvested products, leaching, soil erosion and use of inappropriate nutrient-saving practices has been reported to result in an annual loss of more than 8 million tons of nutrients (Stoorvogel and Smaling, 1990). From about 200 million hectares of cultivated land in 37 African countries, soil fertility depletion due to use of inappropriate nutrient-saving practices in the past 30 years has been estimated at an average of 660 kg N/ha, 75 kg P/ha and 450 kg K/ha (Sanchez *et al*., 1997). In South Eastern Nigeria, the dominant soil types are classified as ultisols and oxisols (Jungerius, 1964). The soils are derived from basement complex rocks, coastal plain sands and from various complexes of sandstones and shales on well-drained sites (FFD, 2002).The soils are rich in free iron but have low mineral nutrient reserve and are therefore characterized by multiple nutrient deficiencies (Ojanuga, 1996). Constraints to crop production on these soils are primarily low nutrient availability and aluminum toxicity (Palm *et al* 2001).

Among the options available for soil fertility maintenance in South Eastern Nigeria, and indeed in the tropics, is the use of prunings of agro-forestry tree species. Agro-forestry trees are indigenous perennial tree crops maintained by farmers on farms and homestead for various agricultural and socio-economic reasons. These tree species are freely available and are characterized by high regenerative, high biomass production and high chemical quality potentials (Tarfa *et al*., 2001). The trees are periodically pruned and utilized as green manures, particularly as source of N and mulching material in line with the objectives of agroforestry technologies (Kang *et al*., 1984; Mafongoya *et al,* 1997). Ladd *et al*. (1981) reported that the main value of leaves from N-fixing agroforestry trees was the accumulation of soil organic matter from the litter fall, which eventually is made available to companion crops in the alley after mineralization.

The effect of trees on crop growth is actually due to a combination of factors such as water and temperature relations, soil structure, soil organic matter, in addition to recycling of nutrients (Palm, 1995). Intercropping of agro-forestry trees with crop plants includes the sequential systems where the trees and crops occupy the same piece of land at different times, and simultaneous systems, where trees and crops are grown on the same piece of land at the same time. In both systems, the intercrop, whether they are annuals or perennials, receive nutrients from the agro-forestry trees (Kang *et al*., 1981).

Despite the considerable available data on biomass and nutrient contents of prunings which exist for several agro-forestry species and the large number of biomass screening trials conducted, it is still presently difficult to make recommendations for a given environment as to which trees produce sufficient pruning biomass with adequate nutrients for sustainable crop yield. This difficulty results from poor documentation of site characteristics and research methodologies. In addition, the nutrient content of agro-forestry prunings depends on many factors, including tree species and the relative proportions of leaves and stems in the prunings and their respective nutrient concentrations. A review information work carried out by Budelman (1989) on nutrient content of leaves of *Leacaena leucocephala and Gliricidia sepium* has shown that within an agro-forestry species, nutrient concentration can vary by a factor of two or more. Differences in nutrient concentration within an agro-forestry tree species can be due to a number of factors, including soil fertility, climate, season, age of leaves or plant or frequency of pruning. Generally, leguminous trees in alley cropping system are reported to produce 20 t/ha/yr dry matter of prunings, containing as much as 358 kg N, 28 kg P, 232 kg K, 144 kg Ca and 60 kg Mg (Young, 1989; Szott et al. 1991). These values are more than enough to meet the nutrient requirement needs of most crops in the tropics particularly, sweet potato (FFD, 2002).

The objectives of this study therefore, are:

(i) To determine the effect of soil amendment with prunings of selected agro-forestry tree species on soil nutrient status and on the growth and yield responses of three sweet potato varieties in the rainforest ecology of South Eastern Nigeria.

(ii) To determine the economics of sweet potato production using prunings of agro-forestry tree species under rain-fed agriculture in Nigeria.

MATERIALS AND METHODS

The study was conducted in 2010 and 2011 cropping seasons at the research farm of the National Root Crops Research Institution Umudike, South Eastern Nigeria (Latitude $05^0 29^1$ N; and Longitude $07^0 33^1$ E) . Before commencement of the study, pre-cropping analysis of the chemical properties of the soil of the experimental site was done using the methods reported by International Soil Reference and Information Centre (2002). The soil of the study site had the following properties: pH (water) of 5.6; total N of 0.24%; total organic matter content of 2.8% and available P of 18 mg/kg. The exchangeable cation contents of the soil were 0.26, 3.60, 1.90 and 0.09 Cmol/kg for K, Ca, Mg and Na respectively. Land preparation (clearing, ploughing, harrowing and ridging) was done using a tractor.

Treatments comprised prunings of three agro-forestry tree species (*Dactyladenia barterii, Gliricidia sepium and Chloropenthra microphylla)* each applied at its agronomic quantity (i.e. quantity required to supply the 60 kg N/ ha recommended for sweet potato production on low fertility soils of South Eastern Nigeria) and in factorial combinations with three sweet potato varieties (Ex-Igbariam, TIS 87/0087 and TIS 2532.OP.113). The recommended NPK fertilizer rate of 400 kg/ha and a plot having neither the agro-forestry tree pruning nor the NPK fertilizer treatment (absolute control) were included as checks. The chemical composition of the agro-forestry tree prunings used for the study is as shown in Table 1. The three agro-forestry tree pruning treatments were used to amend the soil before planting with sweet potato was done. The three agro-forestry trees used in the study have existed for about 5 years (personal interview).

The *C. microphylla* and *D. barterii* pruning treatments were incorporated into the soil by tillage using a spade at 2 weeks before the application of *G. sepium* pruning treatment. This was done to reflect differences in decomposition time of the prunings. The experiment was planted up on 8th and 14th July for 2010 and 2011 cropping seasons respectively using four node cuttings of the various sweet potato varieties tested. The sweet potato vines were planted at a distance of 1 m x 0.30 m giving a plant population of 33, 333 plants/ha.
The treatments were laid out on 5 m x 3 m plots arranged in a randomized complete block design with 3 replications. The NPK fertilizer treatment was band-applied 4 weeks after planting (WAP).

Data on plant height, number of leaves/plant (12 WAP), total fresh-root yield (20 WAP), and saleable and unsaleable root number per plot were collected. For purposes of determining the economic viability of sweet potato production using the agro-forestry tree prunings tested, data on Man-days used for all farm operations and cost of procurement and application of the prunings and other production inputs used in the study excluding land were also collected. The data were analyzed statistically using Analysis of Variance (ANOVA) according to the procedures reported by Gomez and Gomez (1984). Treatment means with significant effects were detected using the Least Significant Difference at 5 % level of probability.

RESULTS AND DISCUSSION

Effect of agro-forestry Tree Pruning and Sweet Potato Variety on Soil Chemical Properties

Relative to absolute control, application of agro-forestry tree pruning tended to increase the chemical properties of the soil used for the study. For an Example, for the two years of study, soil total N increased by 217, 50 and 17 % with the application of *Gliricidia sepium, Chloropenthra microphylla* and *Dactyladenia barterii* prunings respectively relative to absolute control (Table 2). There was no significant difference in soil mineral N response between plots treated with *C. microphylla* pruning and those that received *D. barterii* pruning treatment. Among the three agro-forestry tree species evaluated, use of G. sepium pruning proved to be more superior to *C. microphylla* and *D. barterii* in terms of enhancement of all the soil chemical fertility parameters tested. Improvement in soil total organic carbon was highest in plots that received *D. barterii* pruning treatment followed by *G. sepium* pruning. In general, optimum NPK fertilizer treatment gave the highest significant performances at 8 WAP in terms of soil mineral N, exchangeable bases content and soil available P improvement compared to the agro-forestry tree prunings evaluated in the study (Table 2). There was a significant improvement in soil total organic carbon, exchangeable K, Ca, and available P contents of soil used for the study following amendment with agro-forestry prunings relative to absolute control. This is suspected to be a reflection of the chemical compositions of the pruning materials used. Soil amendment with agro-forestry tree species also resulted in significant increases in soil pH relative to the absolute control. Such increases in soil pH after application of pruning treatment is attributed to the improvement in exchangeable Ca and Mg observed following application of agro-forestry tree prunings. Sweet potato variety had no significant effect on soil response to total N, organic matter, exchangeable K and Na at 8 WAP. But its effect on soil available P and exchangeable Ca was significant. Plots planted with TIS 87/0087 recorded 145 and 88 % increases in exchangeable Ca and 74 and 49 % increases in soil available P relative to TIS 2532.OP.113 and Ex-Igbariam varieties respectively.

Effect of Agro-forestry Tree Pruning and Sweet Potato Variety on Vine Length and Leafiness of Sweet Potato

Both agro-forestry tree pruning source and variety significantly influenced sweet potato response to vine length (Table 3). Averaged over the three pruning sources evaluated, amendment with *G. sepium* resulted in significantly higher mean vine lengths than when prunings of *D. barterii* and *C. microphylla* were used. The least response in vine length for both years was recorded on plots amended with prunings of *C. microphylla*. Use of optimum NPK fertilizer proved to be more superior in terms of sweet potato vine length response at the growth period of 8 WAP than the three agro-forestry tree prunings tested. This trend was expected because fertilizers are relatively simple in structure and break down more easily to provide specific nutritional needs to plants in a rather more quickly manner than organic materials.

The three sweet potato varieties differed significantly in their vine length responses to agro-forestry tree pruning amendment (Table 3). For both years, TIS 2532.OP.113 produced significantly longer vines than TIS 87/0087 and Ex- Igbariam varieties across the three tree pruning sources tested. But in terms of leafiness, TIS 2532.OP.113 variety produced the least response than TIS 87/0087 and Ex-Igbariam (Table 4). This was contrary to the observation made in Table 3.

The superior performances observed in plots that received agro-forestry tree pruning amendment relative to the un-amended control in terms of vine length and leafiness was attributed to the modifying influence of organic residues from the prunings. Organic resources are known to have multiple functions in soil, ranging from their influence on nutrient availability to modification of the soil environment in which plants grow (FiBL, 2012). Because of their richness in carbon, organic resources provide an energy source for soil microorganisms which drive the various soil biological processes that enhance nutrient transformation and other quality parameters of the soil thereby resulting in better crop performances. Among the pruning treatments, *G. sepium* foliage application recorded the highest mean number of leaves/plant in both years irrespective of sweet potato variety while *C. microphylla* and *D.barterii* gave the least responses in 2010 and 2011 respectively.

The better performance of *G. sepium* pruning over the *D. barterii* and *C. microphylla* in terms of vine length and leafiness may be attributed to its superior nutrient quality, especially its nitrogen and potassium contents, which are higher than those of *D. barterii* and *C. microphylla.* As a general rule, organic inputs with a N content of >2.5% or a C:N ratio <16 release nutrients in the short term, allowing a ready supply of nutrients to growing crops within the same season, and nutrient release can reach a peak within 3 weeks of incorporation into soil (ASHC, 2012).

Being a root crop, sweet potato requires appreciable amount of N and K (especially at the initial growth stage of 1- 2 months after planting) for protein synthesis and efficient physiological development and tuber initiation. The chemical qualities of *G. sepium* pruning shown in Table 1 satisfies this condition and perhaps, explains the better responses shown by *G. sepium* treatment in terms of vine length, leafiness and total root yield (Tables 3, 4 and 7).
By contrast, organic inputs having N content of < 2.5% or C: N ratio >16 (as is the case with *D. barterii*), tend to immobilize N nutrient for a considerable period of time (ASHC, 2012) thereby bringing in its wake a condition for nutrient imbalance and inadequate N supply for the growing Sweet potato crop. Therefore, the relatively lower responses exhibited by *D.barterii*- treated plots relative to *G.sepium* and *C. microphylla* in terms of vine length and leafiness may be attributed to insufficiency of N during the critical growth stages of the sweet potato crop as a result of nutrient N immobilization.

When an organic material with a very wide C:N ratio (> 16) like in the case of *D. barterii,* is added to the soil, it will immobilize N for a long time because soil microbes will out-compete the growing crops and lock up the scarce N from the decomposing organic input and the soil into their own tissue production. There was also an observed significant sweet potato variety x agro-forestry tree pruning source interaction effect with respect to vine length. This interaction effect was highest on plots amended with optimum NPK fertilizer followed by *G. sepium* treatment.

Effect of Agro-forestry Tree Pruning and Sweet Potato Variety on Saleable and Un-saleable Root Numbers of Sweet Potato

Relative to the un-amended control, amending the soil with either agro-forestry tree pruning or NPK fertilizer resulted in increased tendency of production of higher number of saleable root and decreased tendency of production of lower number of un-saleable roots (Tables 5 and 6).The results of this study appear to highlight the fact that adequate nutrition either from the organic or inorganic resources is critical in sweet potato production and that adequate plant nutrition is also capable of bringing about competition for photosynthate between the big-sized and the small-sized roots in favour of the former.

Effect of Agro-forestry Tree Pruning and Sweet Potato Variety on Total Root Yield of Sweet Potato

Relative to optimum NPK fertilizer treatment, mean total root yield decreased significantly among the three varieties following the application of agro-forestry pruning indicating that although these tree prunings possess fertilizer potentials, using them alone as main fertilizer source in sweet potato production may not give maximum economic benefit to farmers. In terms of root yield response, plots treated with agro-forestry tree pruning however, outperformed the absolute control (Table 7). This observation notwithstanding, the three varieties exhibited remarkable similarity in their responses to root yield under agro-forestry tree pruning amendment. For both years, total root yield performances of TIS 2532.OP.113 and TIS 87/0087 were slightly better than that of Ex-Igbariam indicating that varietal consideration might also be an important factor for consideration in the selection of agro-forestry tree pruning for use as an amendment material in sweet potato production in South Eastern Nigeria (Table 7).

Economics Analysis of Sweet Potato Production in South Eastern Nigeria Using Agro-forestry Tree Prunings

However, when the return per Naira investment was done, use of *G. sepium* pruning amendment gave the highest return per Naira of N1.45, N1.51 and N1.56 for Ex-Igbariam, TIS 87/0087 and TIS 2532.OP.113 varieties respectively. The results of this study are indicating that total reliance on the native fertility of the soils of South Eastern Nigeria without additional nutrient input from either the organic or inorganic sources is not economically feasible in terms of sustainable sweet potato production in the zone. Although in general, mean total root yield of sweet potato tended to increase significantly with the application of agro-forestry tree prunings across the three varieties evaluated relative to the un-amended control (Table 7), the additional yield increase arising from the use of *D. barterii* pruning does not confer any economic benefit to justify its recommendation to farmers. Therefore, for sustainable sweet potato production, it is better and more economically sensible to use *G. sepium pruning* or *C. microphylla* instead of *D. barterii.*

With the exception of *D. barterii* pruning, all the other amendment materials used in this study (*G. sepium* and *C. microphylla* prunings and optimum NPK fertilizer) proved to be economically advantageous for sweet potato production in the highly weathered soils of South Eastern Nigeria. The magnitude of the economic benefit arising from their use however was variable and a function of sweet potato variety (Table 8). Averaged over the three pruning sources evaluated, TIS 87/0087 and TIS 2532.OP.113 varieties gave higher economic benefits than Ex-Igbariam. Growing sweet potato without any soil amendment (absolute control) proved to be even more economically beneficial than the use of *D. barterii* pruning particularly in the production of TIS 87/0087 and TIS 2532.OP.113 varieties.

CONCLUSION

Soil amendment with prunings of agro-forestry trees enhances soil chemical properties, root yield and yield components of sweet potato compared to when there is no amendment. Such increases in soil chemical properties and sweet potato yield and yield components following application of the treatment are variable and highest when the soil is amended with optimum NPK fertilizer followed by *G. sepium* than with prunings of *D. barterii* and *C. microphylla*. Amending the soil with prunings of *G. sepium* gives the highest return per Naira invested followed by *C. microphylla* and optimum NPK fertilizer. With the exception of *D. barterii* pruning, soil amendment with *G. sepium, C. microphylla* prunings or optimum NPK fertilizer is more economically advantageous for sweet potato production on the highly weathered soil of South Eastern Nigeria than the absolute control.

Table 1: Some chemical composition of the selected multi-purposetree prunings used in the study

Parameter	*P.maximum*	*G.sepium*	*D.barterii*	*C.microphylla*
Total N (%)	1.28	5.60	2.10	3.70
Total P (%)	0.45	290	0.86	2.03
Total K (%)	2.40	3.40	2.30	1.50
Total Ca (%)	1.10	1.20	1,70	1.30
Total Mg (%)	0.56	1.30	0.20	0.84
Total Na (%)	0.07	0.04	0.06	0.006
Total C (%)	30.4	62.00	38.20	45.70
C:N ratio	23.75	11.07	19.19	12.35

Table 2: Effect of Agro-forestry Tree Pruning Amendment on Soil Quality of an Ultisol in South Eastern Nigeria Grown with Three Sweet Potato Varieties (8 WAP) Average of 2010 and 2011 cropping)

Treatment	Total N	Total Org C.	Exch. K	Exch. Ca	Exch. Mg	Exch. Na	Av. P	pH
	………………….(%)	………………..	……………………………(Cmol/kg)	…………………………………..			(mg/kg)	
Agro-forestry Pruning Source:								
Absolute Control	0.12	1.22	0.06	2.14	1.36	0.10	8.24	5.1
Optimum NPK Fertilizer	0.56	2.68	0.34	3.33	2.86	0.14	20.3	6.2
Dactyladenia barterii	0.14	3.84	0.14	2.56	2.27	0.05	14.2	6.4
Gliricidia sepium	0.38	3.56	0.20	5.84	2.86	0.11	16.6	7.2
Chloropenthra microphylla	0.18	2.88	0.18	4.84	1.92	0.08	11.7	6.8
Sweet potato Variety:								
Ex-Igbariam	0.28	2.36	0.18	2.43	1.38	0.10	12.3	5.8
TIS 87/0087	0.30	2.82	0.20	4.56	2.82	0.08	18.3	6.2
TIS 2532.OP.113	0.17	2.22	0.16	1.86	2.45	0.12	10.5	5.4
LSD (0.05):								
Pruning Source	0.12	1.36	0.10	1.867	NS	NS	3.64	1.023
Variety	NS	NS	NS	1.04	NS	NS	3.12	NS
Pruning Source x Variety	NS	NS	NS	NS	NS	NS	NS	NS

Table 3: Effect of Agro-forestry Tree Pruning on the Vine Length (cm) of three Sweet Potato Varieties Grown in an Ultisol in South Eastern Nigeria at 8 WAP

Agro-forestry Pruning	2010				2011			
	Sweet Potato Variety				Sweet Potato Variety			
	Ex-Igbariam	TIS 87/0087	TIS 2532.OP.113	Mean	Ex-Igbariam	TIS 87/0087	TIS 2532.OP.113	Mean
Absolute Control	52.2	67.3	74.3	64.6	61.3	68.3	64.3	64.6
Opt. NPK Fertilizer	145.2	168.4	182.6	165.4	135.4	142.6	201.4	159.8
D. barterii	76.1	88.9	94.1	86.4	86.6	76.8	116.2	93.2
G. sepium	96.6	102.3	115.8	104.9	97.4	112.3	124.8	111.5
C. microphylla	81.6	74.8	88.2	81.5	91.2	82.4	88.5	87.4
Mean	90.3	100.3	111.0	-	94.4	96.5	119.0	-
	LSD (0.05):				LSD (0.05):			
	Variety = 3.268				Variety = 3.898			
	Pruning Source = 6.346				Pruning Source = 5.988			
	Variety x Pruning Source = 2.114				Variety x Pruning Source = 2.067			

Table 4: Effect of Agro-forestry Tree Pruning on the Number of leaves/plant of three Sweet Potato Varieties in an Ultisol in South Eastern Nigeria. (8 WAP)

Agro-forestry Pruning	2010				2011			
	Sweet Potato Variety				Sweet Potato Variety			
	Ex-Igbariam	TIS 87/0087	TIS 2532.OP.113	Mean	Ex-Igbariam	TIS 87/0087	TIS 2532.OP.113	Mean
Absolute Control	47.0	34.3	42.3	41.2	32.3	36.4	33.2	34.0
Opt. NPK Fertilizer	86.0	90.4	94.5	90.3	91.4	81.2	73.6	82.1
D. barterii	69.4	48.7	46.7	54.9	47.7	38.6	40.1	42.1
G. sepium	74.8	66.6	57.5	66.3	87.5	64.2	59.8	70.5
C. microphylla	60.2	51.4	47.3	53.0	62.3	54.3	58.4	58.3
Mean	67.5	58.3	57.7	-	64.2	54.9	53.0	-
	LSD (0.05):				LSD (0.05):			
	Variety = 1.547				Variety = 1.768			
	Pruning Source = 3.088				Pruning Source = 3.025			
	Variety x Pruning Source = NS				Variety x Pruning Source = NS			

Table 5: Effect of Agro-forestry Tree Pruning on the Un-Saleable Root Number/Plot of three Sweet Potato Varieties Grown in an Ultisol in South Eastern Nigeria at 8 WAP

Agro-forestry Pruning	2010				2011			
	Sweet Potato Variety				Sweet Potato Variety			
	Ex-Igbariam	TIS 87/0087	TIS 2532.OP.113	Mean	Ex-Igbariam	TIS 87/0087	TIS 2532.OP.113	Mean
Absolute Control	84.2	67.3	58.4	70.0	94.3	90.4	86.3	90.3
Opt. NPK Fertilizer	56.4	42.3	36.4	45.0	69.6	74.4	68.4	70.8
D. barterii	67.3	52.5	43.1	54.3	78.9	80.5	74.0	77.8
G. sepium	60.2	46.4	42.1	49.6	76.3	78.4	72.5	75.7
C. microphylla	66.4	58.3	47.7	57.5	81.3	82.4	78.6	80.8
Mean	66.9	53.4	45.5	-	80.1	81.2	76.0	-
	LSD (0.05):				LSD (0.05):			
	Variety = 3.379				Variety = NS			
	Pruning Source = 1.573				Pruning Source = 1.227			
	Variety x Pruning Source = NS				Variety x Pruning Source = NS			

Table 6: Effect of Agro-forestry Tree Pruning on the Saleable Root Number/Plot of three Sweet Potato Varieties Grown in an Ultisol in South Eastern Nigeria at 8 WAP.

Agro-forestry Pruning	2010				2011			
	Sweet Potato Variety				Sweet Potato Variety			
	Ex-Igbariam	TIS 87/0087	TIS 2532.OP.113	Mean	Ex-Igbariam	TIS 87/0087	TIS 2532.OP.113	Mean
Absolute Control	27.4	36.8	42.6	35.6	22.3	33.4	36.4	30.7
Opt. NPK Fertilizer	85.5	88.3	92.4	88.7	78.8	82.1	86.0	83.2
D. barterii	48.7	52.8	64.6	55.4	66.6	58.0	62.2	62.3
G. sepium	76.8	79.2	81.0	79.0	72.2	69.7	75.7	72.5
C. microphylla	65.5	72.3	77.6	71.8	65.5	64.4	68.8	66.2
Mean	60.8	65.9	71.6	-	61.1	61.5	65.8	-
	LSD (0.05):				LSD (0.05):			
	Variety = 1.705				Variety = NS			
	Pruning Source = 3.340				Pruning Source = 3. 217			
	Variety x Pruning Source = 1.664				Variety x Pruning Source = NS			

Table 7: Effect of Agro-forestry Tree Pruning on the Total Root Yield (t/ha) of three Sweet Potato Varieties Grown in an Ultisol in South Eastern Nigeria at 8 WAP

Agro-forestry Pruning	2010				2011			
	Sweet Potato Variety				Sweet Potato Variety			
	Ex-Igbariam	TIS 87/0087	TIS 2532.OP.113	Mean	Ex-Igbariam	TIS 87/0087	TIS 2532.OP.113	Mean
Absolute Control	5.5	8.1	9.2	7.6	4.8	6.7	7.4	6.3
Opt. NPK Fertilizer	15.5	18.4	20.1	18.0	14.8	15.8	17.0	15.9
D. barterii	9.7	11.4	12.3	11.1	8.8	10.3	10.7	9.9
G. sepium	13.6	15.4	16.4	15.1	12.6	14.8	14.9	14.1
C. microphylla	12.3	13.4	14.2	13.3	11.4	12.6	13.3	12.4
Mean	11.3	13.3	14.4	-	10.5	12.0	12.7	-
	LSD (0.05):				LSD (0.05):			
	Variety = NS				Variety = NS			
	Pruning Source = 0.654				Pruning Source = 0.732			
	Variety x Pruning Source = NS				Variety x Pruning Source = NS			

Table 8: Summary of Economics of sweet potato production at Umudike using Agro-forestry tree prunings and NPK fertilizer at the prevailing market price of N30/kg. Average of 2010 and 2011 cropping

Treatment	Variables	Agro-forestry Tree Pruning Source				
		Absolute Control	Optimum NPK Fertilizer	*Dactyladenium barterii*	*Gliricidia sepium*	*Chloropenthra microphylla*
Ex- Igbariam	Yield (t/ha)	6.95	16.95	10.5	14.6	12.85
	Gross Return (N)	208,500	508,500	315,000	438,000	385,500
	Total Production Cost (N)	218,000	398,000.70	376,284.40	300,567.12	297,234.20
	Return (N)	-9,500	110,499.30	-61,284.4	137,432.88	88,265.80
	Return/ Naira invested	-1.04	1.28	-1.16	1.45	1.30
TIS 87/0087	Yield (t/ha)	7.4	17.1	10.85	15.1	13.0
	Gross Return (N)	222,000	513,000	325,500	453,000	390,000
	Total Production cost (N)	218,000	398,000.70	376,284.40	300,567.12	297,234.20
	Return (N)	4,000	114,999.30	-50,784.4	1.51	92,765.80
	Return/ Naira invested	1.02	1.29	-1.13		1.31
TIS2532.OP.113	Yield (t/ha)	8.3	18.55	11.5	15.65	13.75
	Gross Return (N)	249,000	556,500	345,000	469,500	412,500
	Total Production Cost (N)	218,000	398,000.70	376,000	300,567.12	297,234.20
	Return (N)	31,000	158,499.3	-31,000	168,932.88	115,265.80
	Return/Naira invested	1.14	1.40	-1.08	1.56	1.39

REFERENCES

Africa Soil Health Consortium (2012). Hand Book for Integrated Soil Fertility Management edited by Thomas Fairhurst, CAB International.

Budelman, A. (1989). Nutrient Composition of the Leaf Biomass of three Selected Woody Leguminous Species; Agro-forestry Systems 8: 39 – 51.

Federal Fertilizer Department (FFD) (2002). Fertilizer Use and Management Practices for Crops in Nigeria. In: E.A. Aduayi, V.O.Chude, B.A. Adebusuyi and S.O.Olayiwola (eds.) Fertilizer Use and Management Practices for Crops in Nigeria. A co-publication of the Federal Fertilizer Department, Federal Ministry of Agriculture and Rural Develpoment and National Programme on Food Security Abuja, Nigeria.

Gomez,K.A. and Gomez, A.A. (1984).Statistical Procedure for Agricultural Research. 2nd edition, John Wiley and Sons, New York, NY.

International Soil Reference and Information Centre (2002). Procedures for Soil Analysis Compiled and edited by L.P. van Reeuwijk. ISRIC and FAO Publication.

Jungerius, P.D. (1964). The Soils of Eastern Nigeria. Publications Service Geologigue du-Luxembourg 14: 185- 198.

Kang, B.T., Wilson, G.F. and Sipkens, L. (1981). Alley Cropping Maize and Leaucana leucocephala (Lam.) in Southern Nigeria. Plant and Soil 63: 165- 179

Kang, B.T., Wilson, G.F., and Lawson, T.L. 1984. Alley Cropping: A Sustainable Alternative to Shifting Cultivation. IITA, Ibadan, Nigeria.

Ladd, J.N., Oades, J.M. and Amato, M. (1981). Distribution and Recovery of Nitrogen from Legume Residue Decomposing in Soils Sown to Wheat in the Field. Soil Biology and Biochemistry 13: 251-256.

Mafongoya, P L., Dzowela, B.H., Nair, P.K. (1997). Effect of multipurpose trees, age of cutting and drying method on pruning quality. In Cadisch, G.; Giller, K. E. Eds. Driven by Nature: Plant Litter Quality and Decomposition. CAB International, Wallinford, U. K. 167-174.

Ojanuga, A.G. (1996). Pedoecological classification in support of sustainable development in Nigeria: A case study of Nigeria. Proceedings of the 3rd All African Soil Science Conference held at University of Ibadan.

Palm, C.A., Gachengo, C.N., Dalve, R.J., Cadisch, G. and Giller, K.E. (2001) Organic Inputs for Soil Fertility Management in Tropical Agroecosystems: Application of an Organic Resource Database. *Agriculture, Ecosystems andEnvironment*. 83: 27-42.

Sanchez, P. A., Shepherd, K. D., Soule, M.J., Place, F.M., Mokwunye, A. U., Buresh, R. J., Kwesiga, F.R., Izac, A.N., Ndiritu, C. G., and Woomer, P.L. (1997). Soil fertility Replenishment in Africa: An investment in natural resource capital. In Replenishing soil fertility in Africa, ed. R.J. Buresh and P. A. Sanchez. SSSA Special Publication. Madison, Wisconsin, USA

Stoorvogel, J.J. and Smaling, E. M. A. (1990). Assessment of soil nutrient depletion In Sub-Saharan Africa. 1983 – 2000. Report 28. Wageningen. The Netherlands: The Winand Staring Centre for Integrated Land, Soil and Water Research (SC – DLO)

Szott, L.T., Fernandes, E.C.M. and Sanchez, P.A. (1991). Soil-Plant Interactions in Agro forestry Systems. Forest Ecology and Management 45: 127-152.

Tarfa, B. D., Uyovbisere, E .O., Chude, V.O., Raji, B. A. and Yaro, D. T. (2001). Effect of Complementary use of foliage of Azadirachta indica, Parkia biglobosa and NPK on yield and nutrient uptake of maize in a Savanna soil. Nigerian Journal of Soil Research 2: 43 – 50

Young, A. (1989). Agro-forestry for Soil Conservation. International Council for Research and Agro-forestry and CAB International, Wallingford, UK.