GLOBAL JOURNAL OF BIO-SCIENCE AND BIOTECHNOLOGY

www.scienceandnature.org

STUDIES ON THE POTENTIALS OF NEEM AND ALBIZIA PRUNING AS SOIL AMENDMENT

M. O. Aduloju[1], F. Y. Adelana[2] & O. M. Shuaib[2]
[1]Department of Crops and Soil Science, Landmark University, Omu-Aran, Kwara State, Nigeria
[2]Department of Agronomy, University of Ilorin, Ilorin, Kwara State, Nigeria
*Corresponding author's E-mail: omolola__ad @yahoo.com

ABSTRACT
Field trials were conducted at the University of Ilorin Teaching and Research Farm in 2010 and 2011 planting seasons to assess the effectiveness of inorganic fertilizer nitrogen, rattle tree (*Albizia lebbeck)* and neem (*Azadirachta indica*) pruning in supplying Nitrogen, Phosphorous and Potassium in the soil, and to compare these effects on the soil nutrients with that of inorganic nitrogen fertilizer (Urea) on the soil. The treatments comprised of rattle tree and neem tree pruning at three levels (0, 1, 1.5 and 2 tonnes per hectare) and inorganic fertilizer (Urea) at four levels (0, 20, 40 and 60 kg N/ha). The treatments were replicated four times in a Randomized Complete Block Design (RCBD) and the changes in total N, available P and exchangeable K contents of the soil were measured and recorded. The results showed that both tree pruning, when buried in the soil, are capable of adding N, P and K to the soil for crop production.

KEY WORDS: *Albizia lebbeck, Azadirachta indica,* inorganic fertilizer, crop production.

INTRODUCTION

Crop yields are usually low in many developing countries because most farmers rely on the native soil fertility, either for lack of knowledge of what to apply to the soil to improve production, being too poor to buy fertilizers, inability to purchase fertilizers due to scarcity, or undue bureaucracy at the point of purchase. Declining soil fertility has been identified as the fundamental cause of declining crop yields in many parts of Africa (Sanchez *et al.*, 1997). Soil is a natural resource that supports plant and animal life. Its properties (physical, chemical and biological) can change in response to use and management practices as a result of natural processes (Adeyolanu, 2010).

Rattle tree (*Albizia lebbeck* L. Benth.) is a leguminous, multi-stemmed tree which nodulates abundantly and fixes atmospheric nitrogen into the soil. Neem tree (*Azadirachta indica* A. Juss.) is one of the most widespread tree species in Nigeria and grows under a wide range of conditions. It has a wide variety of uses, ranging from medicinal to economical (Keay *et al*., 1964).

For many years, emphasis has been laid on the need to improve the nutrient status of impoverished soils in the tropics by applying mineral fertilizers in a bid to increase and sustain agricultural production. Nitrogen as an element is abundantly available in the atmosphere (about 79%), but very deficient in most soils because it is highly mobile in the soil. Several tonnes of chemical fertilizers are purchased yearly to remedy soil nitrogen deficiencies. Apart from its being expensive, its application could adversely affect the ozone layer, thereby causing increase in skin cancer and rates of mutation in organisms due to harmful radiation (Alexander, 1982). Integration of the pruning of nitrogen-fixing and non-nitrogen fixing trees into the soil has been identified as one of the ways of increasing the organic matter and nitrogen content in most savanna soils. These soils are characterized by low nutrient content and poor structure due to continuous cultivation and rapid soil degradation (Alasiri, 1997). The use of organic amendment to supply soil nutrients has become widespread. Also, there is awareness the world over about the more healthy nature of organically-grown food. The objectives of this study therefore are to evaluate the potentials of rattle tree and neem tree pruning as soil amendment and to determine their effect on the nitrogen, phosphorous and potassium contents of the soil studied, compared with the expensive and often unavailable inorganic fertilizer urea.

MATERIALS & METHODS

The study site

The study was carried out at the University of Ilorin Teaching and Research farm, Ilorin, Nigeria. The area is located in the southern Guinea savanna zone of Nigeria (Lat. 8^{o} 29'N and Long. 4 ^{o} 35'E). The rainfall pattern is bimodal and peaks around July and September. The annual rainfall is between 1250 - 1500mm with dry periods from mid-July to August and annual temperature range of 19^{o}C – 33^{o}C.

Field studies

The field trials were carried out in the cropping (rainy) seasons of 2010 and 2011. The test crop was okra *(Abelmoschus esculentum)*. The experiment was laid out in a Randomized Complete Block Design (RCBD), having 4 replicates. Each plot size was 5m by 4m in size. There were twelve treatments: Rattle tree and Neem leaves at 0, 1.0, 1.5 and 2.0 t/ha; and Urea fertilizer at 0, 20, 40 and 60 kg N/ha. The zero rates were the control to which nothing was applied. The tree pruning was buried in the center of the ridge and left to decompose. Soil samples were taken

before the pruning was buried. Urea fertilizer treatments were applied to the plants as side dressing two weeks after the tree pruning was buried. The pre-treatment soil samples of the study area was taken, air-dried and sieved with a 2 mm sieve, then analyzed for physical and chemical properties. Post-treatment soil samples were also taken from each plot at two weekly intervals from 0-8 weeks after planting (WAP), air dried, sieved and analyzed for Nitrogen (N), Phosphorus (P) and Potassium (K). The N, P and K contents of the pruning at the time of collection for the experiment were determined in the laboratory.

The soil pH was determined in water (1:1 soil: water ratio) using a glass electrode pH meter (IITA, 1982). Particle size analysis was determined by the hydrometer method as described by Gee and Bauder (1986). Percentage organic carbon was determined using the Potassium dichromate wet oxidation method of Nelson and Sommers (1996). Available P and K were determined using the Wolf and Beegle (1995) method. Total nitrogen was determined by the macro–Kjeldahl digestion method (Jackson 1962).

RESULTS & DISCUSSION

Soil physical and chemical properties

The physical and chemical properties of the experimental soil before treatment application are as shown in Table 1.

TABLE 1: The general characteristics of the experimental soil before treatment application.

Property	Value
Sand (%)	70.37
Silt (%)	20.01
Clay (%)	9.62
Textural class	Sandy loam
pH (1:1 Soil/H_2O)	6.7
OM (g/kg)	2.38
Total N (g/kg)	0.13
Available P (mg kg^{-1})	7.29
Exchangeable K^+ cmol/kg soil	0.17
Ca^{++} cmolkg	2.38
Mg^{++} cmol/kg	0.56
Na^+ cmol/kg	0.24
CEC cmol/kg	3.64

The soil is slightly acidic in nature and sandy loam in texture. The organic matter content was found to be 1.38 mg/kg. This is considered low, according to the ratings by Landon (1991). The total N content of 0.13 g/kg was lower than the critical level of 1.5g/kg recommended for tropical soils by Enwenzor *et al.* (1979). The available P was found to be 7.29 mg/kg soil. This is also below the critical level of 10-16 mg/kg recommended by Adeoye and Agboola (1985). The K status of the soil (0.17 cmol/kg) was also found to be less than the critical level of 0.2 cmol/kg soil reported by Adeoye (1986). It can be concluded that the soil is generally poor in the major essential nutrients. The need for additional nutrients is therefore well established and response to such added nutrients is expected. The low soil fertility observed in the experimental soil in respect of total Nitrogen, phosphorus and potassium contents are characteristic of the savannah soils of Nigeria in general. However, nitrogen has been identified as the most limiting plant nutrient element in these soils and it is in consonance with the reports of Lombin (1983) and Ogunwale (2003).

The NPK content of the tree pruning

The nutrient components of the fresh pruning used at the time of incorporation into the soil is as shown in Table 2. Rattle tree pruning (RTP) had higher P, K, Ca and Mg than Neem Tree Pruning (NTP), but the latter had a slightly higher percentage of Nitrogen.

TABLE 2: Nutrient content of Neem and Rattle tree pruning used.

Nutrient element	*NTP	**RTP
N (%)	2	1.5
P (mg/kg)	0.2	0.5
K (cmol/kg)	1.8	2.5
Ca (cmol/kg)	0.9	1.8
Mg (cmol/kg)	0.4	0.6
*NTP =	Neem Tree Pruning	
**RTP =	Rattle Tree Pruning	

Effect of applied pruning on soil NPK content

The NPK contents of the experimental soil over time as influenced by the application of the different levels are as shown in Tables 3 -8. Tables 3 and 4 show the effect of the application of the different treatments levels on the N content of the experimental soil over time for the two years of study (2010 and 2011) respectively. The highest value recorded for total nitrogen was obtained at 6 and 8 (WAP) for Neem treatment at 1.5 t/ha (0.44% and 0.47% respectively), while the lowest (0.14%) was recorded at 8

WAP for the control (0.14). This is because the rotting pruning is still releasing nutrients into the soil continuously. This is confirms the fact that most nitrogen-supplying organic fertilizers contain nutrients which are released slowly for plant use. The P content of the soil was highest at 6 WAP from Neem at 1.5 t/ha (9.50 mg/kg) and lowest at 0 WAP in Rattle Tree at 1.0 t/ha (1.25 mg/kg). However, Rattle Tree treatment at 1.0 t/ha recorded the highest soil K content at 4 WAP (0.33 cmol/kg) and Neem at 2.0 t/ha (0.33cmol/kg) at 6 WAP.

TABLE 3: Effect of application of different rates of Rattle Tree and Neem pruning and fertilizer (Urea) on the experimental soil Nitrogen content in the two years of planting

	Soil Nitrogen Levels									
	0 WAP		2 WAP		4 WAP		6 WAP		8 WAP	
	YEARS									
Treatment	1	2	1	2	1	2	1	2	1	2
Rattle tree leaves @ 1t/ha	0.13	0.22	0.25	0.24	0.26	0.32	0.11	0.34	0.10	0.30
Rattle tree leaves @ 1.5t/ha	0.14	0.28	0.26	0.30	0.28	0.32	0.21	0.38	0.18	0.34
Rattle tree leaves @ 2.0t/ha	0.11	0.20	0.16	0.24	0.17	0.36	0.14	0.39	0.13	0.34
Neem tree leaves @ 1 t/ha	0.10	0.28	0.18	0.22	0.18	0.30	0.16	0.34	0.16	0.25
Neem tree leaves @ 1.5 t/ha	0.13	0.32	0.23	0.47	0.25	0.32	0.30	0.44	0.17	0.27
Neem tree leaves @ 2.0 t/ha	0.12	0.40	0.18	0.34	0.18	0.28	0.14	0.34	0.14	0.28
Urea @ 20kg/ha	0.13	0.16	0.16	0.34	0.16	0.18	0.11	0.28	0.10	0.18
Urea @ 40kg/ha	0.12	0.12	0.18	0.20	0.26	0.22	0.19	0.30	0.10	0.11
Urea @ 60kg/ha	0.13	0.16	0 .16	0.20	0.16	0.18	0.16	0.25	0.14	0.19
Control	0.11	0.28	0.11	0.18	0.08	0.26	0.07	0.25	0.05	0.14

TABLE 4: Phosphorus content of the experimental soil as influenced by the application of different rates of Rattle Tree, Neem pruning and N fertilizer (Urea) after two years of planting

	Soil P Levels (mg/kg soil)									
	0 WAP		2 WAP		4 WAP		6 WAP		8 WAP	
	YEARS									
Treatment	1	2	1	2	1	2	1	2	1	2
Rattle leaves @1.5t/ha	1.05	3.55	3.42	4.15	3.68	5.45	5.95	7.10	5.24	5.60
Rattle leaves @2.0t/ha	0.51	2.45	0.70	3.20	0.72	6.10	0.18	5.70	0.12	4.80
Neem leaves @1t/ha	1.10	3.20	1.75	3.70	1.77	7.00	1.75	7.10	1.43	6.60
Neem leaves @1.5t/ha	0.23	2.45	0.53	3.90	0.55	8.85	1.05	9.95	1.01	5.95
Neem leaves @2.0t/ha	1.37	3.90	1.93	4.65	1.94	7.10	1.40	8.20	1.28	5.45
Urea @20kg/ha	0.15	2.10	0.53	2.25	0.53	4.65	1.23	6.10	1.14	3.26
Urea @40kg/ha	0.17	2.75	0.70	2.96	0.72	3.70	2.98	4.85	2.52	3.42
Urea @60kg/ha	0.21	2.30	0.35	3.50	0.40	4.60	1.58	4.00	1.34	3.90
Control	0.13	2.65	0.08	2.85	0.06	2.80	0.05	3.55	0.04	2.05

TABLE 5: Average Potassium content of the experimental soil as influenced by the application of different rates of Rattle Tree, Neem pruning and N fertilizer (Urea)

	Soil K Levels (cmolg/kg soil)									
	0 WAP		2 WAP		4 WAP		6 WAP		8 WAP	
	YEARS									
Treatment	1	2	1	2	1	2	1	2	1	2
Rattle leaves @1t/ha	0.13	0.19	0.15	0.21	0.18	0.33	0.25	0.23	0.22	0.14
Rattle leaves @1.5t/ha	0.17	0.13	0.17	0.13	0.23	0.25	0.32	0.19	0.28	0.19
Rattle leaves @2.0t/ha	0.07	0.22	0.08	0.18	0.10	0.25	0.20	0.23	0.18	0.16
Neem leaves @1t/ha	0.09	0.11	0.11	0.23	0.15	0.25	0.24	0.20	0.21	0.23
Neem leaves @1.5t/ha	0.11	0.13	0.13	0.18	0.17	0.26	0.30	0.19	0.30	0.21
Neem leaves @2.0t/ha	0.13	0.08	0.11	0.11	0.16	0.30	0.18	0.33	0.16	0.23
Urea @20kg/ha	0.10	0.11	0.10	0.23	0.11	0.23	0.18	0.22	0.18	0.19
Urea @40kg/ha	0.14	0.14	0.14	0.13	0.14	0.19	0.25	0.23	0.20	0.21
Urea @60kg/ha	0.11	0.13	0.10	0.11	0.10	0.24	0.12	0.15	0.10	0.24
Control	0.10	0.15	0.10	0.29	0.08	0.26	0.08	0.16	0.06	0.17

CONCLUSION

Based on the results from this study, it can be concluded that Neem and Rattle Tree fresh pruning have the potential to improve the soil fertility in the soils of the study area when incorporated into the soil. These trees are abundant in the study area and therefore could be used as soil nutrient supplements for organically produced arable and vegetable crops such as okra. The different levels of plant nutrients in the tree pruning at various stages of growth need to be determined to confirm or refute this finding.

REFERENCES

Adeoye, G.O. and Agboola, A. A. (1985) Critical levels for soil pH, available P, K, Zn and maize leaf ear content of P, Cu and Mn in sedimentary soils of South Western Nigeria. ***Fertilizer Research***, 6:65-71.

Adeoye, G. O. (1986) Comparative Studies of Some Extractants for Sedimentary Soil of South Western Nigeria. Ph.D Thesis, University of Ibadan.

Adeyolanu, O.D., G.A Oluwatosin, K.S Are, A.O Oke and A.O Adelana (2010) Effects of slash and burn on soil quality of an Alfisol: Soil Chemical Indicators. Pp 52 – 57. In: Proceedings of the 34th Annual Conference of the Soil Science Society of Nigeria.

Alasiri, K. O. (1997) Soil management strategies for horticultural crop production in Nigeria. Occasional paper No. 38, NIHORT, Ibadan, Nigeria. 1997. Pp 1–9. ISSN 0795–4123.

Alexander, M. (1982) Research to enhance nitrogen fixation: Misplaced emphasis. Priorities in biotechnology research for International developments. Proceedings of a workshop. Washington, D.C. National Academy press. Pp 208 – 299.

Enwenzor, W.O., Udo, E.J., Usoroh, N. J., Ayotade, K.A., Adepetu, J.A., Chude, U.O. and Udegbe, C.J. (1979) Fertilizer Use and Management Practices for Crops in Nigeria (Series No 21) Produced by Fertilizer Procurement and Distribution Division of the Fed. Ministry of Agriculture, Water Res. and Rural Dev., Lagos, Nigeria.

Gee, G. W., and Bauder, J. W (1986) Particle Size Analysis. Pp. 383 – 411. In: Klute, A. (ed.) Methods of Soil Analysis Part 1: Physical and Mineralogical Methods. Agronomy Monograph No 9 (2nd edition). American Society of Agronomy, Madison, W.I., U. S. A.

International Institute of Tropical Agriculture (1982) Selected Methods for Plant and Soil Analysis IITA. Manual Series No.7. IITA, Ibadan, Nigeria. Pp 1-17.

Jackson, M. L. (1962) Soil Chemical Analysis. Prentice Hall, New York. Pp 4-8.

Keay, R.W.J., Onochie, C. F. A., and Stanfield, D. P. (1964) Nigerian Trees. Vol.II. Nigerian National Press Ltd., Apapa. Published by the Department of Forest Research, Ibadan.

Landon, J. R. (1991) Booker Tropical Soil Manual: A Handbook for Soil Survey and agricultural evaluation in the Tropics and Sub-tropics. John Wiley and Sons Inc., New York. Pp. 74.

Lombin, G. (1983) Evaluating the Micronutrient Status of the Nigerian Semi-arid Savanna Soils: Copper and Manganese. **Soil Science** 135 (6):377-384.

Nelson, D. W., and Sommers, I. E. (1996) Total carbon, organic carbon and organic matter, pp 961 – 1010. In: Sparks, D.L (ed). Methods of Soil Analysis, Part 3. Chemical Methods, SSSA Book Series. Number 5. American Society of Agronomy, Madison, Wisconsin, U. S. A.

Ogunwale, J. A. (2003) Soil Phosphorus and Phosphate Fixation. 3rd Faculty of Agriculture Seminar, University of Ilorin, Ilorin, Nigeria. p 20.

Sanchez P. A., Shepherd, K. D., Soule, M. J., Place, F. M., Buresh, R. J., Izac, A. M., Mokwunye, A. U., Kwesiga, F. R., Nderitu, C. G. and Woomer, P. L. (1997) Soil fertility replenishment in Africa: An investment in natural resource capital pp 1 – 46. In: Buresh, R.J., P.A Sanchez and F. Calhoun (eds.). Replenishing Soil Fertility in Africa. SSSA Special Publication No 51, Madison, Wisconsin.

Wolf, A.M. and Beegle, D. B. (1995) Recommended soil tests for macronutrients: Phosphorus, potassium, calcium and magnesium. Pp 25 – 34. In: Thomas Sims and Wolfs A. (eds.). Northeast Regional Bulletin, No 493. Agric. Expt. Station, University of Delaware, Newark, DE, U.S.A.