Pertanika J. Trop. Agric. Sci. **26(1)**: 19 - 25 (2003)

ISSN: 1511-3701

Raising Oil Palm Seedlings in Urban Cities Using Sole and Amended Woodash and Sawdust Manurial Treatments

E. I. MOYIN-JESU[1] & E. F. CHARLES[2]

[1]*Agronomy Department,*
Federal College of Agriculture, AKURE,
Ondo State

[2]*Nigerian Institute for Oil*
Palm Research, P. M. B. 1030,
BENIN-CITY,
Nigeria

Keywords: Oil palm seedlings, organic fertilizer, woodash, sawdust, manurial treatments

ABSTRAK

Biji benih yang sihat diperlukan sebagai prasyarat bagi kejayaan penanaman kelapa sawit. Tanah yang sesuai untuk penanaman ini amat terhad di kawasan bandar. Oleh itu, satu kajian telah dijalankan di hutan hujan Akure (Lat 7ºN, 5'10'E), Barat Daya Nigeria tentang keberkesanan penggunaan abu kayu dan habuk kayu yang biasa digunakan dengan campuran najis kambing, babi dan binatang ternakan sebagai baja tumbesaran, khasiat daun dan komposisi kimia tanah bagi penanaman kelapa sawit (Elaies guineesis L). *Lapan jenis baja rawatan telah dibandingkan dengan kawalan (tanpa baja, tanpa najis binatang) dan NPK 12:12:17 + baja Mg 2. Rawatan tersebut diaplikasikan ke atas 40 g dalam setiap polibeg yang diisi dengan 10 kg tanah (8t/hat), diterbalikkan sebanyak tiga kali dan disusun atur secara rawak. Baja organik dan tanah tersebut dianalisis secara kimia. Keputusan menunjukkan bahawa aplikasi organik tersebut meninggalkan sisa di dalam tanah dan meningkatkan ($P<0.05$) tanah dan daun N,P, K, Ca, Mg, nilai pH tanah dan O.M, ketinggian tumbuhan, lilitan batang dan jumlah daun pokok kelapa sawit tersebut berbanding rawatan kawalan. Abu kayu + najis binatang ternakan dan habuk kayu + najis binatang ternakan, mencatatkan nilai tanah, khasiat daun dan parameter tumbesaran yang lebih tinggi terhadap kelapa sawit tersebut berbanding NPK + baja Mg. Abu kayu + najis binatang ternakan telah meningkatkan nilai pH tanah, O.M, N, P, K, Ca, Mg dan Na dengan kadar masing-masing 14.8%, 328%, 75%, 51%, 8.4%, 2546%, 58% dan 1123%, berbanding NPK dan baja rawatan Mg. Abu kayu + najis binatang ternakan tersebut juga telah meningkatkan N, P, K, Ca dan kandungan khasiat Mg terhadap daun pokok kelapa sawit dengan kadar masing-masing 3%, 38%, 20%, 266% dan 200% mengatasi baja NPK dan juga telah meningkatkan kelebaran daun, lilitan batang, jumlah daun dan berat tunas dengan kadar masing-masing 14%, 22.75%, 17% dan 57% mengatasi NPK + baja Mg. Walau bagaimanapun, NPK + baja Mg telah memberikan nilai N, P dan K, ketinggian tumbuhan, kelebaran daun, jumlah daun dan berat tunas yang baik berbanding abu kayu dan habuk kayu yang diaplikasikan secara berasingan. Manakala aplikasi organik tersebut meninggalkan sisa di dalam tanah dan meningkatkan ($P<0.05$) tanah dan Ca dan Mg daun berbanding baja. Abu kayu dan habuk kayu yang diaplikasikan secara berasingan atau yang diubah pada 8t/ha telah memberikan kesan ke atas sumber khasiat baja bagi tumbesaran benih kelapa sawit.*

ABSTRACT

A healthy seedling is a pre-requisite for a successful establishment of oil palm planting in the field. There were very limited soils available in the urban cities for raising of oil palm seedlings. Therefore, a study was conducted in Akure (Lat 7ºN, 5'10'E) in the rainforest zone of South West Nigeria on the effectiveness of woodash and sawdust used ordinarily or in combination with goat, pig and poultry manure as fertilizers on the growth, leaf nutrients and soil chemical composition of oil palm (Elaies guineesis L) *seedlings in the nursery. Eight organic fertilizer treatments were compared to the control (no fertilizer; no manure) and NPK 12:12:17 + Mg 2 fertilizer.*

The treatments were applied at 40 g per polybag filled with 10 kg soil (8t/ha), replicated three times and arranged in a complete randomized block design. The organic fertilizers and soils were chemically analysed. The results showed that the application of organic residues to the soil significantly increased (P<0.05) the soil and leaf N, P, K, Ca, Mg, Soil pH and O. M, plant height, stem girth and number of leaves of oil palm seedlings compared to the control treatment. Woodash + poultry manure and sawdust + poultry manure gave higher values of soil, leaf nutrients and growth parameters of oil palm seedlings than NPK + Mg fertilizer. Woodash + poultry manure increased the soil pH, O. M, N, P, K, Ca, Mg and Na by 14.8%, 328%, 75%, 51%, 8.4%, 2546%, 58% and 1123% respectively when compared to NPK + Mg fertilizer treatment. The woodash + poultry treatment increased the oil palm seedling leaf N, P, K, Ca and Mg nutrient contents by 3%, 38%, 20%, 266% and 200% respectively more than NPK fertilizer while it also increased the leaf area, stem girth, number of leaf and shoot weight by 14%, 22.75%, 17% and 57% respectively more than the NPK + Mg fertilizer. However, NPK + Mg fertilizer gave better values of soil N, P, and K, plant height, leaf area, number of leaves and shoot weight than woodash and sawdust applied in sole forms while the organic residues significantly increased (P<0.05) soil and leaf Ca and Mg compared to the fertilizer. Woodash and sawdust applied solely or amended at 8t/ha has been effective as sources of fertilizer nutrients for raising oil palm seedlings.

INTRODUCTION

The oil palm (*Elaies guineensis*) belongs to the family palmea. It is the most important source of a palm oil and produces more oil per hectare than any of the oil producing crops. The palm oil is used for much domestic cooking, manufacture of soap, production of margarine and candles.

Folorunso and Akinyemi (1999) reported that there has been a phenomenal increase in production of oil palm, cashew and coffee seedlings in urban cities by individuals and horticultural farmers for income generation, self employment, and as supplement to the demand among farmers in the rural areas, whose palms are ageing on the field or by city dwellers who need few oil palm seedlings for planting to meet their families' cooking needs.

The production of oil palm seedlings covers a period of between ten and twelve months from the pre-germinated seeds to the maturity stage for transplanting and it is usually between October and July to be ready at the onset of rains. The inhabitants in cities use the available land spaces in the backyard of their homes, riversides and other unutilized spaces for raising the seedlings of oil palm. Both city and rural dwellers raise livestock (goat, pig and poultry) and their wastes constitute serious health hazards to the people because they are not utilized for crop production.

The vast potential of the oil palm crop is being threatened by continued decline in soil fertility and this is because the same piece of land is used for filling the polybags of oil palm seedlings. Efforts to increase the soil nutrient status through the use of inorganic fertilizers are accompanied by high cost, scarcity at farmers' level and probable degradation of soil by continuous use (Folorunso 1999).

A critical review of literature showed that there was a scarcity of research information on the use of woodash and sawdust residues applied alone or in combination with goat, pig and poultry manure to raise the crop at the seedling stage in the nursery and field.

Therefore, the objective of this paper was to investigate the effectiveness of these organic residues on the soil, leaf nutrient content and growth parameters of oil palm seedlings in the nursery at Akure, Nigeria.

MATERIALS AND METHODS

The experiments were carried out at Akure (7^0N', $5^0$10'E) in the rainforest zone of Nigeria in 1997 and 1999 on the same site. The soil is a sandy loam, skeletal, kaolinitic, 150 hyperthemic oxic paleustalf (Alfisol) or Ferric Luvisol (FAO) while the annual rainfall is 1300 mm and the temperature is 70^0C.

The samples of the surface (0-15 cm) soils used for the raising of oil palm seedlings were collected, airdried, sieved with a 2 mm sieve and utilized for routine soil analysis. The particle size was determined by the hydrometer method (Bouycous 1951). The soil pH (1:1 soil/water) and 1.2 soil/0.01M Cacl2 solutions were calculated using a glass/calomel electrode system (Crockford and Mourell 1956). The organic matter was determined by Walkley and Black (1934). The exchangeable bases (K, Ca, Mg and Na) were extracted with 1M NH_4 OAC pH7 and

the amounts of K, Ca and Na were determined on flame photometer using appropriate element filters while the Mg content in the extract was read on atomic absorption spectrophotometer (Jackson 1958).

The exchangeable acidity (H^+ and Al^{3+}) was measured from 0.01 M Kcl extracts by titrating with 0.1M HCL (Mclean 1965). Percentage N was determined using the microkjedahl method (Jackson 1964). Available P was extracted using Bray P1 extractant and the amount in the extract measured with Murphy-Riley blue method (Murphy and Riley 1962) on spectronic 20 at 882 Um. Ten kg of surface (0-15 cm) soil from the site of the experiment was weighed into each of 150 black polythene bags (1400 cm^3). Water was added and allowed to equilbrate at field capacity for 48 h. These polybags were arranged on the flat ground.

There were eight manurial treatments, viz-sawdust (sole), sawdust + poultry manure, woodash + goat dung and woodash (sole), woodash + pig dung, woodash + goat dung and woodash = poultry manure. Zero manure and NPK + Mg 12-12-17 + 2 fertilizer were applied as control and reference treatments respectively.

The manure treatments were applied at the rate of 40 g per bag (8t/ha) for the ordinary forms of woodash and sawdust while their amendment with goat, pig dung and poultry manure were applied at a ratio of 50:50% by weight (20 g each). The NPK + Mg fertilizer was applied at a single rate of 2 g per polybag (400 kg/ha) to each of the five bags as reference treatments and there were five blank treatments (zero fertilizer or manure) as control. The manure or fertilizer treatments were mixed thoroughly with the soils in polybags using hand fork ten days before planting sprouted oil palm seedlings. The experiment was laid out using a completely randomized design (CRD) with three replicates in which the manurial treatments were the only sources of variation.

The sprouted teneral hybrid oil palm seeds were planted per bag and a shade was built to prevent the seedlings from scorching by sun and they were watered daily. Weeding was carried out at 2, 6 and 10 weeks after planting and 20 mL a. i. of basudin in 5 L of water was also sprayed on the site every 3 weeks to control termite attack while 20 mL a. i. of dithane M-45 in 6 L of water was sprayed on the seedlings against fungus attack at 4 and 9 weeks after planting.

Measurement of the growth parameters of oil palm seedlings started seven weeks after planting. Plant height, leaf area and stem girth (cm) were measured using ruler, graph method and calipher respectively. The measurements were taken at one week intervals till 13 weeks after planting. The leaf population measurement started from the 15th week after planting and shoot weight was determined at the time of transplanting.

Before transplanting, the shade was slightly reduced to thicken the seedlings. Fresh leaf samples were taken at 18 WAP from the seedlings and put into labeled envelopes and oven-dried for 2 days at 70^0C to obtain dry leaf samples. They were milled into powdered forms and 2 g of the sample weighed for dry ashing in muffle furnace at 500^0C for 6 h. Five mL of water was added to the ash and %P was determined by phospho-vanade molybdate coloration on spectronic 20 at 442 Um. The N content was determined by microkjedahl distillation process and K, Ca, and Na contents were determined on flame Photometer while Mg was determined using atomic absorption spectrophotometer.

The chemical analysis of the manurial treatments earlier used for raising the oil palm seedlings was also determined. At harvest (35 WAP), soil samples were taken from each bag, air-dried, sieved and analysed for nutrient contents. The data obtained for the growth parameters, leaf and soil chemical composition of oil palm seedlings were analysed using ANOVA F-test and the overall treatment mean effects were compared using Duncan multiple range test at 5% level.

RESULTS

The physical and chemical properties of the soils used for raising the oil palm seedlings are presented in Table 1. The soils are low in organic matter if compared with the critical level of 3% O.M. (Agboola and Carey 1973). The total nitrogen is less than 0.16% considered as optimum for oil palm production (Omoti *et al.* 1990).

The available P is less than 10 mg/kg P considered as adequate for crops (Agboola and Carey 1973), while the exchangeable K, Ca, Mg and Na contents were lower than the 0.22, 0.20, 0.27 and 0.17 mg/kg critical levels considered as adequate for oil palm seedlings respectively (Agboola 1982c).

TABLE 1
Chemical analysis of the soil before the experiment

pH		Organic Matter	N	P	Exchangeable Cations			
H_2O	Caclz	%		mmol/kg	Na	K	Ca	Mg
					mmol/kg Soil			
6.10	5.50	0.65	0.096	7.89	0.17	0.112	0.192	0.15

The low values of soil K, Ca, Mg, Na, P total N, soil pH and O.M were indications of soils with poor fertility status and oil palm seedlings growth on the soil would respond favourably to the application of the organic fertilizer materials. The soils were sandy loam in texture, skeletal, kaolinitic, isohyperthermic, oxic paleustalf (Alfisol) or perric Luvisol (FAO) or Akure series.

Table 2 shows the chemical properties of the organic fertilizer materials used in the experiment. The goat and pig dung had lower contents of N, P, K, Ca and Mg compared to poultry manure while the nutrient composition of woodash was higher than sawdust. The C/N values of goat dung, pig dung and poultry manure were lower than that of woodash and sawdust respectively.

The soil N, P, K, Ca, Mg, Na, O.M and pH (Table 3), leaf N, P, K, Ca and Mg (Table 4) and leaf area, plant height, stem girth, shoot weight and leaf population (Table 5) of oil palm seedlings in the nursery of treated soils increased significantly ($P<0.05$) relative to the control treatment.

Among the plant residues, woodash gave better values of growth parameters of oil palm seedlings such as plant height (12.27 cm), leaf area (35.48 cm^2), stem girth (1.80 cm), leaf population (4.80) and shoot weight (1.60 kg) than the corresponding values of 11.38 cm, 35.21 cm^2, 1.58 cm, 4.35 and 1.10 kg in sawdust (sole) treatment. The woodash also gave higher leaf and soil N, P, K, Ca, Mg, Na, soil O.M and pH.

Relative to NPK + Mg fertilizer, the woodash and sawdust (sole) treatments had lower growth parameters such as plant height, leaf area, stem girth, shoot weight and leaf population (Table 5). It also had lower leaf and soil N, P and K contents than the NPK fertilizer (Tables 3 and 4).

However, the woodash and sawdust (sole and amended) gave higher values of soil O.M, pH, Ca, Mg and Na than NPK fertilizer. For instance, woodash + poultry manure treatment increased soil O.M (3%), pH (7.89), Ca (3.44 mmol/kg), Mg (1.31 mmol/kg) and Na (2.08 mmol/kg) when compared to the corresponding values of soil O.M (0.7%), pH (5.90), Ca (0.13 mmol/kg), Mg (0.83 mmol/kg) and Na (0.19 mmol/kg), respectively in NPK fertilized treatment.

The amended woodash and sawdust with goat, pig and poultry manure gave higher growth, soil and leaf nutrient contents than their sole forms. The amendment of woodash + poultry manure had highest soil P, K, Ca, Mg and Na compared to woodash amended with pig and goat manure respectively. The soil O.M and pH decreased under the NPK + Mg fertilizer and control treatments.

TABLE 2
Chemical analysis of the organic fertilizers used for the experiment

Organic Materials	C	N	Organic Matter	C/N ratio	Available P	Exchangeable cations			
						Na	K	Ca	Mg
			%		mg/P	mg/L			
Poultry manure	32.10	4.53	50.30	7.08	376.10	6.10	10.62	2.90	4.30
Goat dung	22.00	2.60	36.51	8.46	169.10	7.40	10.52	2.70	3.80
Sawdust	9.00	0.43	11.73	20.90	12.10	4.39	5.41	0.14	0.90
Woodash	20.20	1.54	32.53	12.98	80.30	9.60	25.12	12.14	9.30
Pig manure	25.00	3.72	33.10	6.72	312.00	5.22	14.45	3.10	4.80

TABLE 3
The values of soil properties at harvest produced by using different organic residues for oil palm seedlings in the nursery (1997 to 1999)

Treatments	pH	O.M	N	P	K	Ca	Mg	Na
Control (No fertilizer)	5.10a	0.55a	0.09a	6.10a	0.11a	0.15a	0.15a	0.17a
NPK12-12-17+Mg	5.90b	0.70b	0.20h	29.73e	6.17h	0.13a	0.83f	0.19b
Woodash (Sole)	8.351	2.57e	0.11c	25.78d	6.15h	2.60h	1.66h	1.16g
Woodash + goat dung	8.00g	2.37d	0.13d	42.54h	4.80f	2.58f	1.46g	1.98l
Woodash + pig dung	9.01h	2.73f	0.18f	4.19l	6.69l	3.51h	1.59l	1.63h
Woodash + poultry manure	7.89f	3.00j	0.35j	44.76j	6.69l	3.44g	1.31f	2.08j
Sawdust (Sole)	7.22d	1.67c	0.10b	7.90b	2.29b	0.33b	0.20b	0.37c
Sawdust + goat dung	7.24e	2.84i	0.16e	30.59f	3.02e	0.51c	0.3d	0.58e
Sawdust + pig dung	7.01c	2.75g	0.19g	25.55c	2.37c	0.33b	0.21c	0.51e
Sawdust + poultry manure	7.24e	2.81h	0.24l	41.06g	2.95d	0.58d	0.37e	0.61f

Treatment means within each column followed by the same letters are not significantly different from each other using Duncan Multiple Range Test at 5% level.

TABLE 4
The mean values for the leaf nutrient contents at harvest produced by the different organic residues for oil palm seedlings in the nursery

Treatments	N	P	K	Ca	Mg
			%		
Control (No fertilizer)	0.20a	0.016a	0.03a	0.04b	0.007ab
NPK 12-12-17 + Mg	1.61h	0.08c	0.53c	0.003a	0.006a
Woodash (Sole)	0.46c	0.09cd	1.06h	0.074g	0.018d
Woodash + goat dung	1.56g	0.08c	0.85f	0.069ef	0.19e
Woodash + pig dung	1.64hi	0.07bc	0.60e	0.082h	0.031h
Woodash + poultry manure	1.66l	0.11ef	0.73g	0.11i	0.018d
Sawdust (Sole)	0.21b	0.06b	0.36b	0.03c	0.013c
Sawdust + goat dung	0.60d	0.15g	0.56c	0.05d	0.026f
Sawdust + pig dung	0.73e	0.10e	0.42d	0.06e	0.03fg
Sawdust + poultry manure	0.78ef	0.10e	0.64ef	0.068e	0.035i

Treatment means within each column followed by the same letters are not significantly different from each other using Duncan Multiple Range Test at 5%

TABLE 5
The values of growth parameters of oil palm seedlings produced by using different organic residues

Treatments	Plant Height Cm	Leaf area cm^2	Stem girth Cm	Number of leaf +	Shoot weight ++ kg
Control (No fertilizer)	7.35a	27.26a	1.38a	4.10	0.50a
NPK 12-12-17 + Mg	16.60fg	42.27c	1.89cd	5.30e	1.80cd
Woodash (Sole)	12.27c	35.48b	1.80c	4.80c	1.60c
Woodash + goat dung	12.27c	42.10c	1.85cd	5.60b	2.00e
Woodash + pig dung	16.13f	45.31e	1.79d	5.67f	2.10ef
Woodash + poultry manure	16.21f	48.08g	2.01e	6.20f	2.83i
Sawdust (Sole)	11.38b	35.21b	1.58b	4.35b	1.10b
Sawdust + goat dung	14.29e	43.87d	1.81c	5.16d	2.40g
Sawdust + pig dung	13.32d	47.40f	2.08e	5.93g	2.50h
Sawdust + poultry manure	16.37fg	58.46h	2.52f	6.48l	3.56j

Note: + = At 21 – 25 WAP (Weeks after planting)
++ = At 35 WAP

Treatment means within each column followed by the same letters are not significantly different from each other using Duncan Multiple Range Test at 5% level.

DISCUSSION

The soils used for raising oil palm seedlings were generally low in pH, O.M, N, P, K, Ca and Mg, and these could be responsible for the poor growth of oil palm seedlings in the control treatment. The observation supported that of Agboola (1982c) who had reported poor growth of cocoa and, oil palm seedlings in soils not fertilized. Hence, it was expected that the application of woodash and sawdust in sole forms or amended with goat, pig and poultry manure to the soils would increase the growth responses, soil and leaf nutrient content of oil palm seedlings.

Adepetu and Anyaduba (1983) reported that the acidic soils were not conducive for good performance of oil palm seedlings. This was because nutrient uptake by oil palm is adversely affected by soil acidity; hence, the application of woodash and sawdust residues increased soil pH, thereby reducing soil acidity. The observation was further corroborated by Folorunso (1999) who reported that continuous use of NPK + Mg fertilizer would lead to increase in soil acidity, Ca and Na deficiency stymptoms.

The better leaf and soil Ca, Na, soil pH and O.M under residue and manure treatments compared to NPK fertilizer is consistent with the fact that the organic materials are sources of all plant residues (Swift and Anderson 1992) including Ca and Na not supplied by the NPK fertilizer.

The increases in growth parameters such as plant height, leaf area and stem girth of oil palm seedlings by NPK fertilizer could be associated with quick release of the nutrients for assimilation. However, the organic residues increased the leaf and soil qualities of oil palm seedlings.

The performance of amended woodash and sawdust treatments in growth parameters of oil palm seedlings compared to the sole treatments can be adduced to the high P, K, Ca, Mg contents and lower C:N ratio of the manures which would aid decomposition and release of nutrients.

Among the types of animal manure, the poultry manure was generally more effective in improving plant nutrients (N, P, K, Ca and Mg) status, plant height, leaf area, leaf population and stem girth of oil palm seedlings whereas the goat gave the least P, K, Ca and growth parameters. This was consistent with the fact that it had the highest N, P, K, Ca, Mg, Na and micronutrients. The woodash residue increased leaf K, Ca and Mg compared to sawdust and this could be adduced to its nutrient composition and lower C:N (Folorunso 1999). All these facts will aid quick establishment of oil palm seedlings in the nursery and field.

CONCLUSION

It is concluded that plant residues such as woodash and sawdust were effective as fertilizer and sources of nutrients for oil palm seedlings. Their application enhanced leaf, soil and growth of oil palm seedlings in the nursery.

Amendment of the residue with pig, goat and poultry manure improved their effects on the growth of leaf and soil content of oil palm seedlings.

The research also proved that improved utilization of these residues will increase prospects of farming activities in the cities for poverty alleviation.

It is, therefore, recommended that organic residues such as woodash, sawdust and their amendment with goat, pig and poultry manure applied at 40 g per 10 kg soil (8t/ha) are very useful as fertilizer materials for improving the nutrient availability and ensuring sustainable cultivation of oil palm seedlings on lowly fertile soil in humid tropics.

This recommendation corroborates with the fact that inorganic fertilizers are scarce and expensive for the resource poor farmers and some city dwellers who are the growers of oil palm seedlings in most developing countries.

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(Received: 8 August 2000)
(Accepted: 31 October 2001)