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EVALUATION OF SELECTED BURNT PLANT RESIDUES AND MINERAL FERTILIZERS ON SOIL PROPERTIES AND NUTRIENT UPTAKE AND GROWTH PARAMETERS OF OIL PALM SEEDLINGS

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ABSTRACT

Oil palm seeds are difficult to grow due to poor viability; that is why they are raised in nursery. Addition of right and adequate fertilizer is needed to improve soil fertility. Thus, an experiment was conducted in 2022 to compare the effect of empty palm bunch (EPBA) ash, cocoa pod husk ash (CPHA), kola pod husk ash (KPHA), NPK 20:10:10, urea, calcium ammonium nitrate (CAN) and muriate of potash (MOP) fertilizers on soil properties, nutrients uptake and growth parameters of oil palm seedlings in Ondo, southwestern Nigeria. Soil samples were collected from Adeyemi Federal University of Education oil palm plantation. Each of the dried empty palm bunch, kola pod husk and cocoa pod husk was burnt and applied as treatments at the rate of 0, 2, 4 and 6 g 900-g^{-1} soil while NPK 20:10:10, urea, MOP and CAN fertilizers were individually applied at 2 g 900-g^{-1} soil. The 16 treatments were replicated four times and arranged in completely randomized design. A 900 g of soil was put in each poly pot and planted with Tenera variety of oil palm and watered with 50 cl water daily. The native soil used for the experiment was deficient in major nutrients and adequate in minor nutrients. Relative to the control, application of 2, 4 and 6 g ash types significantly increased plant height, number of leaves, root length and plant girth. NPK, recorded the highest increase in plant height. Leaf length and root length were highest with the application of 6 g KPHA. Application of 6 g EPBA recorded the highest biomass, dry and wet weight and seedlings moisture content. Kola pod husk ash applied at 6 g plant^{-1}. Empty palm bunch ash applied at 6 g plant^{-1} and cocoa pod husk ash applied at 4 g plant^{-1} compared favourably with mineral fertilizers in raising vigorous and healthy oil palm seedlings.

Key words: ash types, leaf area, nursery, plants' nutrients, sprouted seedlings

INTRODUCTION

Nursery is a common practice that is used in raising vigorous seedlings for the establishment of tree crops. Vigorous seedlings usually lead to optimum yield in the field. The seedlings that are tender and stunted in growth at their early stages of life are not likely to survive or produce maximum yield. The seeds of most crops especially oil palms cannot be planted *in-situ* because majority of them are not likely to germinate. Nursery is the foundation for every successful oil palm plantation. It must produce healthy seedlings having the potential for sustaining large oil and kernel yields. Productivity of oil palm trees in production of palm oil which is the major produce from the plant as well as kernels depends on its genotype and good management practices adopted at the early stage of their vegetative growth. Nursery is a place where adequate care can be given to oil palm seedlings. The care involved selection of viable seeds, timely weeding, fertilizers application, watering and controlling of pests and diseases. Good production of oil palms requires fertile soils of which the major nutrients such as nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), and magnesium (Mg) must be adequately present and in proper balance. Most of the southern Nigeria soils where oil palms are predominantly grown are low in plant nutrients due to continuous cropping. It is hard to get a very fertile soils for raising oil palm seedlings without additional nutrients from external sources. Hence, the switch to addition of fertilizers. Mineral fertilizers are commonly used in the nursery as they are handy and are prompt at releasing nutrients to the soil; but due to economic meltdown, they are costly and are not readily available. Sometimes, farmers tend to use organic fertilizers and limes in replacement of mineral fertilizers. Organic fertilizers usually contain reasonable amount of N and P while limes such as burnt plant wastes contain high amount of K and Ca.

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Oil palms require high amount of N, P and K at their early stage. Consequently, Adekunle (2014) suggested a continuous evaluation of the soils for growth and nutritional need of plantation crops. The major objective of this research was to compare the effect of selected mineral fertilizers and burnt plant wastes on the growth parameters of oil palm seedlings.

METHODOLOGY

Experimental Site

The soil of Adeyemi Federal University of Education oil palm plantation was used for the raising of oil palm seedlings. The site selected was near a river as raising of oil palm seedlings requires sufficient water during the dry season. Ondo town is located in latitudes 7° 04' 60.00" N and longitudes 4° 49' 59.99" E with land elevation of 253.23 m (Harpstead, 1974).

Preparation of Soil Samples

Soil samples were collected, bulked, air dried and 900 g of them were weighed into each poly pot. The poly pots were bought from the local market in Ondo town.

Ash Preparation

Palm bunches were collected from Adeyemi oil palm plantation while cocoa pod and kola pod husk were collected from the farmers' fields. The plant residues collected were air dried and burnt into ash. Partial burning method was used in order to reduce volatilization of some vital elements such as N, P and organic carbon. Partial burning is a simulation of local farmers' method of burning plant wastes in south-western Nigeria where this experiment was conducted. The burnt plants ash was allowed to cool and thereafter sieved with 2-mm mesh to remove the carbon and impurities. The ashes were kept in plastic rubber.

Nursery Preparation

The site was cleared with cutlass, refuse was packed and the ground was leveled with hoe. Structure was erected with bamboo and covered with oil palm fronds. Wire mesh was used to surround the site to protect the seedlings against rodents (Figure 1).

Experimental Design

Three levels of oil palm bunch ash, kola pod ash and cocoa pod ash at 0, 2, 4, and 6 *g*, as well as 2 *g* each of NPK 20:10:10, urea, CAN, and muriate of potash fertilizers were individually added into 900 *g* poly pots and were replicated four times. There were four poly pots that contained only 900 *g* soil to serve as control. The fourteen treatments were laid out on completely randomized design (CRD). The poly pots were perforated to avoid waterlogging.

Planting and Management of Germinated Oil Palm

Sprouted oil palm seeds (Tenera variety) were obtained from Nigeria Institute for Oil Palm Research (NIFOR) Benin. The sprouted seeds were planted 2 cm deep with the radical pointing down and the plume pointing up and covered with light soil. Each poly pot was watered with 50 liters of water at three days' interval after planting. Weeds were manually removed.

Data Collection

Plant parameters

Data collected were on plant height, number of leaves, leaf area and stem girth at six months after trans-planting. Plant height was determined with meter rule. Number of leaves and number of dead leaves were counted. Leaf area was determined by measuring the width and length of leaves and multiply by a factor of 0.76. Plant girth was determined with Venier caliper. On dry matter determination, seedlings were transferred into a well labeled paper envelope, moved to the laboratory and oven-dried until constant weight is obtained.

Soil and Leaf Analysis

Oil palm leaves were harvested, labelled, washed and air-dried. The air-dried leaves were packed inside envelopes and oven dried till constant weight was achieved. The nutrients determined were N, P, K Ca, Mg, iron (Fe), copper (Cu), zinc (Zn) and manganese (Mn). The leaf samples were oven-dried and digested with nitric/perchloric acid mixture (2:1). The cations, Ca, Mg, K, and sodium (Na) were analyzed by atomic absorption spectrophotometer (AAS) through flame ionization method (Chapman and Kimstach, 1996). The chemical properties of both the burnt plant residues and the soil used for the experiment such as pH, organic carbon, N, P, K, Ca, and Mg were determined. The micronutrients determined were Fe, Cu, Zn and Mn. Organic carbon was determined by Walkley-Black wet oxidation method (Nelson and Sommers, 1982).

Figure 1: Experimental nursery

The method used in the nitrogen analysis was micro-Kjedahl distillation technique (Bremner and Mulvaney, 1982). Available phosphorus was extracted by Bray-1-method (Bray and Kurtz (1945). Exchangeable bases (Ca, Mg, and K) were extracted with neutral ammonium acetate and determined from the filtrate by atomic absorption spectrophotometer. The Fe, Cu, Zn, and Mn were extracted with hydrochloric acid and determined with atomic absorption spectrophotometer.

Statistical Analysis

Data was analyzed using simple tables, means, standard error and standard deviation.

RESULTS

The soil chemical properties of the soil used for the experiment is shown in Table 1. The recommendation of 2-3% organic matter (OM), 8-10 mg kg^{-1} available P, 0.15% total N, 0.60-2.00 cmol kg^{-1} K, 2.40 cmol kg^{-1} Ca and Mg by Ayeni *et al.* (2008b) and Akinde *et al*. (2020), as the nutrients critical level for southwestern Nigeria were used to explain the nutrients availability of the soil. The nutrients composition of the soil before treatments were applied showed that the soil was acidic, low in available P adequate in K, Ca and Mg. The soil was adequate in Cu, Zn, Mn and Fe. The soil needs additional N and P.

The nutrients composition of cocoa pod ash, oil palm bunch ash and kola pod husk ash as well as MOP, urea, CAN and NPK is shown in Table 2. Among the ash types, cocoa pod husk ash (CPHA) had the highest K, Ca and Mg and lowest organic carbon (OC) that was expected to mineralize early due to its low carbon/nitrogen (C/N) ratio, kola pod husk ash (KPHA) recorded the highest OC, N, P and C/N. Empty oil palm bunch ash had the highest Ca and Mg. Muriate of potash is only rich in K, urea and CAN are rich in N. The ash types are expected to enjoy plant balanced nutrition as they contain most of the essential nutrients useful for oil palm seedlings production. The N, P, and K contents in agro-wastes used in this experiment were low when compared with the mineral fertilizers. The amount of nutrients in each of the fertilizers would determine its performance on crops. The effect of fertilizer types on growth parameters is shown in Table 3. Application of 4 *g* of cocoa pod ash had the highest increase in leaf length, leaf area, plant girth and root length among the seedlings treated with CPHA. Among the seedlings treated with kola pod husks, the seedlings that had 6 *g* of KPHA recorded the highest leaf area, plant height, biomass, wet and dry weight while the seedlings treated with 4 *g* of KPHA recorded the highest number of leaves and root length. Among the seedlings treated with mineral fertilizers, the plants that received NPK 15:5:15 fertilizer recorded the highest plant heath, root length, leaf area, plant girth, weight of dry and fresh weight of oil palm seedlings. On oil palm seedlings treated with empty palm oil bunch ash, 6 *g* of EPBA had the highest increase in number of leaves, leaf length, leaf area, plant girth and root length. Compared EPBA, CPHA, KPH, NPK 20:10:10, urea, CAN and MOP fertilizers with control, plant height, leaf length, root length, biomass, weight of fresh and dry weight of oil palm seedlings as well as moisture content of the seedlings were higher than the control. Among all the treatments, NPK, recorded the highest increase in plant height while the control experiment recorded the lowest plant height values. Leaf and root lengths were highest with the application of 6 *g* KPHA while potash fertilizer recording lowest value in leaf length and 2 *g* KPHA had lowest leaf length. Application of 6 *g* EPBA recorded the highest biomass, dry and wet weight as well as moisture content of the seedlings. Application of 2 *g* KPHA recorded the lowest root length, control experiment recorded the lowest biomass, fresh and dry weight of oil palm seedlings while 2 *g* EPBA recorded the lowest moisture content of the oil palm seedlings.

Table 1: Initial soil chemical properties

Soil properties	Values
pH	4.92
Organic carbon (%)	2.30
Nitrogen (%)	1.03
Phosphorus (mg kg^{-1})	6.2
Potassium (cmol kg^{-1})	0.29
Calcium (cmol kg^{-1})	2.45
Magnesium (cmol kg^{-1})	1.05
Micronutrients (mg kg^{-1})	
Copper	7.59
Zinc	39.01
Manganese	90.00
Iron	380.21

Table 2: Nutrient composition of ash types (%)

	Organic carbon	Nitrogen	Carbon/nitrogen ratio	Phosphorus	Potassium	Calcium	Magnesium
Cocoa pod husk ash	8.50	0.65	13.00	0.70	12.00	2.80	0.99
Kola pod husk ash	21.80	1.02	21.00	0.40	4.67	1.60	0.24
Empty oil palm bunch ash	10.90	0.56	19.00	0.08	0.30	6.99	3.50
Muriate of potash	-	0.00	-	0.00	60.00	0.00	0.00
NPK 15:15:15	-	15.00	-	15.00	15.00	0.00	0.00
Calcium ammonium nitrate	-	26.00	-	0.00	0.00	-	0.00
Urea	-	46.00	-	46.00	0.00	0.00	0.00

Table 3: Plant parameters of oil palm seedlings fertilized with mineral fertilizers and ash type

Treatment	PH (cm)	NL	LL (cm)	PG (cm)	RL (cm)	BW (g)	WF (g)	WD (g)	MC (%)
Control	2.00	2.00	12.00	2.20	12.00	3.40	2.70	2.10	78.00
2.00 *g* CPHA	3.50	4.00	21.20	2.00	13.00	5.10	4.10	3.60	80.00
4.00 *g* CPHA	3.00	4.00	20.00	2.50	16.20	9.90	6.90	6.20	70.00
6.00 *g* CPHA	3.00	3.00	10.00	1.80	14.40	11.01	7.70	6.80	80.00
2.00 *g* KPHA	3.00	2.00	12.00	2.00	1.80	4.10	3.10	2.60	84.00
4.00 *g* KPHA	3.50	4.00	21.00	3.00	14.00	4.80	3.60	3.10	86.00
6.00 *g* KPHA	3.50	4.00	32.50	2.20	27.50	9.60	8.90	7.10	80.00
2.00 *g* NPK	7.00	4.00	26.00	3.50	25.00	10.90	8.20	5.40	67.00
2.00 *g* urea	6.00	2.00	15.00	2.40	14.00	7.40	6.10	4.80	79.00
2.00 *g* MOP	3.00	4.00	9.00	2.00	3.00	5.10	4.00	3.10	78.00
2.00 *g* CAN	5.00	3.00	17.00	2.30	17.00	5.90	4.70	3.50	75.00
2.00 *g* EPBA	4.00	4.00	21.00	2.30	12.00	7.50	5.40	3.10	57.00
4.00 *g* EPBA	3.00	4.00	20.00	2.50	17.50	10.30	8.70	6.90	79.00
6.00 *g* EPBA	3.00	5.00	23.00	2.70	21.00	11.20	9.10	8.50	97.00
Mean	3.71	3.64	18.60	2.39	14.90	7.60	5.94	4.77	77.90
SE	0.37	0.23	1.75	0.12	1.88	0.76	0.61	0.54	2.50
SD	1.37	0.84	6.55	0.45	7.05	2.85	2.30	2.03	9.24

PH - plant height, NL - number of leaves, LL - length of leaves, PG - plant girth, RL - root length, BW - biomass weight, WF - weight of fresh seedlings, WD - weight of dry seedlings, MC - moisture content of seedlings, SE - standard error, SD - standard deviation, CPHA - cocoa pod husk ash, KPHA - kola pod husk, NPK - nitrogen/phosphorus/potassium, MOP - muriate of potash, CAN - calcium ammonium nitrate, EPBA - empty palm bunch ash

Table 4 shows the nutrients uptake by oil palm seedlings fertilized by mineral fertilizers and ash types. Among the oil palm fertilized with CPHA, 6 *g* CPHA absorbed the highest N, P, K, Ca, Mg, Mn, Zn and Fe while 4 *g* CPHA recorded the highest Cu. Among the mineral fertilizers, it was found that the oil palm seedlings absorbed the nutrients which the fertilizers were majorly composed. For example, urea had the highest N content, potash had the highest P. For micronutrients under study, urea recorded highest Zn and Mn, CAN recorded highest Cu while potash recorded the highest. Among the seedlings treated with KPHA, 6 *g* KPHA recorded the highest N, P, K, Ca, Mg, Cu, Zn and Mn uptake. Also, EPBA recorded the highest N, P, K, Ca, Mg, Zn and Cu uptake while 2 *g* EPBA recorded the highest Mn and Fe uptake. Considering all the treatments, urea fertilizer recorded the highest N and Mn, 6 *g* CPHA recorded the highest P, K, Zn and Fe, CAN fertilizer recorded the highest Ca uptake, 6 *g* EPBA recorded the highest Mg uptake while 4 *g* CPHA recorded the highest Cu uptake.

The soil chemical properties after the termination of the experiment are shown in Table 5. The results show that the soil samples fertilized with 4 and 6 *g* CPHA recorded the highest pH while urea fertilizer recorded the lowest pH. The pH fertilized with 6 *g* CPHA tends to neutral level. Generally, all the three ash types used as treatments in this experiment mineral, i.e., CPHA, KPHA and EPBA increased soil pH than the selected mineral fertilizers for the study. Cocoa pod husk ash applied at 4 and 6 *g* and; EPBA applied at recorded the highest OM though not significant when compared other treatments. Calcium ammonium nitrate fertilizer (CAN) recorded the highest

Table 4: Nutrients uptake of oil palm seedlings fertilized with mineral fertilizers and ash types

Treatment	Nitrogen	Phosphorus	Potassium	Calcium	Magnesium	Copper	Zinc	Manganese	Iron
	(mg plant^{-1})								
Control	11.50	7.29	10.03	2.10	2.00	10.54	46.02	90.36	379.01
2.00 *g* CPHA	12.45	6.72	30.40	4.45	3.78	13.47	46.44	98.42	402.38
4.00 *g* CPHA	14.44	6.77	37.82	4.79	3.99	17.89	46.39	98.42	400.00
6.00 *g* CPHA	14.45	7.89	40.47	4.93	4.54	16.48	46.43	97.31	412.20
2.00 *g* NPK	30.42	17.42	20.03	2.92	2.04	10.02	48.10	98.10	386.09
2.00 *g* urea	37.10	7.95	13.12	2.21	2.14	10.98	49.73	100.78	380.12
2.00 *g* MOP	10.00	10.15	29.14	1.23	2.01	12.14	46.98	97.37	391.17
2.00 *g* CAN	13.14	7.09	14.00	6.72	2.51	14.13	40.15	67.68	203.14
2.00 *g* KPHA	14.16	7.78	21.14	3.10	2.92	10.78	48.72	98.99	400.72
4.00 *g* KPHA	14.67	8.49	22.17	3.78	2.99	12.19	49.44	100.42	424.41
6.00 *g* KPHA	14.72	9.62	29.18	3.99	3.17	12.29	53.67	105.16	481.72
2.00 *g* EPBA	10.79	10.34	22.63	3.92	3.72	10.69	50.00	91.41	380.00
4.00 *g* EPBA	16.96	11.00	27.69	4.23	4.21	11.43	50.67	91.07	380.00
6.00 *g* EPBA	16.97	12.76	34.44	4.67	5.55	11.67	52.67	89.09	381.02
Mean	16.65	9.38	25.20	3.79	3.26	12.50	48.20	70.38	360.00
SE	2.03	0.78	2.46	0.37	0.29	0.62	0.89	6.94	29.10
SD	0.55	2.93	9.21	1.40	1.09	2.31	3.33	2.59	108.87

SE - standard error, SD - standard deviation, CPHA - cocoa pod husk ash, KPHA - kola pod husk, NPK - nitrogen/phosphorus/potassium, MOP - muriate of potash, CAN - calcium ammonium nitrate, EPBA - empty palm bunch ash

Table 5: Soil chemical properties of oil palm fertilized with mineral fertilizers and ash types

Treatment	pH	OM	Nitro-gen	Phos-phorus	Pota-ssium	Calcium	Magne-sium	Iron	Zinc	Manga-nese	Copper
		(%)		(mg kg^{-1})		(cmol kg^{-1})			(mg kg^{-1})		
Control	4.79	2.61	1.13	8.72	0.07	2.03	1.31	36.11	1.60	6.00	2.23
2.00 *g* KPHA	4.93	2.60	1.13	9.02	0.10	2.16	1.37	33.12	1.67	6.13	2.43
4.00 *g* KPHA	4.99	2.63	1.19	9.09	0.15	2.29	1.37	34.17	1.70	6.17	2.62
6.00 *g* KPHA	5.01	2.67	1.19	9.23	0.19	2.42	1.45	32.13	1.89	6.19	2.24
2.00 *g* CPHA	5.00	2.67	1.13	9.34	0.22	2.99	1.41	23.14	1.56	5.92	2.43
4.00 *g* CPHA	6.72	2.69	1.14	9.37	0.47	3.71	1.53	20.66	1.56	5.99	2.44
6.00 *g* CPHA	6.93	2.69	1.14	9.59	0.69	4.01	1.67	16.34	1.54	5.15	2.17
2.00 *g* EPBA	4.98	2.61	1.14	8.90	0.19	2.14	1.42	32.16	1.60	5.96	2.00
4.00 *g* EPBA	5.01	2.65	1.14	8.96	0.23	2.26	1.67	30.71	1.57	5.96	2.03
6.00 *g* EPBA	5.08	2.69	1.16	8.99	0.36	2.96	1.98	30.62	1.53	5.99	2.17
2.00 *g* NPK	4.70	2.65	2.45	13.42	0.97	2.14	1.34	38.13	1.66	6.03	2.26
2.00 *g* urea	4.66	2.65	3.01	8.95	0.07	2.01	1.34	38.17	1.63	6.17	2.68
2.00 *g* MOP	4.84	2.60	1.16	8.70	1.34	2.15	1.36	38.19	1.69	6.00	2.69
2.00 *g* CAN	5.00	2.67	1.19	8.99	0.09	2.95	1.40	32.01	1.78	6.21	2.00
Mean	5.22	2.65	1.38	9.38	0.37	2.59	1.47	31.12	1.64	2.99	2.60
SE	0.69	0.01	0.16	0.32	0.10	0.17	0.05	1.79	0.03	0.07	0.29
SD	0.91	0.03	0.53	1.19	0.38	0.64	0.19	6.69	0.10	0.26	1.07

SE - standard error, SD - standard deviation, CPHA - cocoa pod husk ash, KPHA - kola pod husk, NPK - nitrogen/phosphorus/potassium, MOP - muriate of potash, CAN - calcium ammonium nitrate, EPBA - empty palm bunch ash, OM - organic matter

value of total N followed by NPK among the treatments. Application of NPK recorded the highest P followed by KPHA, CPHA and EPBA at all rates. Muriate of potash performed better than all other treatments in supplying K to the soil. All the ash types supplied Ca and Mg to the soil better than the mineral fertilizers in this experiment. NPK, MOP, Urea and CAN added more Fe, Zn, Mn and Cu to the soil than the ash types at all rates. The finding in this research shows that the higher the nutrient composition of each fertilizer, the higher the amount of the nutrients released to the soil by the fertilizer.

DISCUSSION

The low nutrients status of the soil used for the experiment indicates that it requires additional nutrients. Hence, application of nutrients from different mineral fertilizer types was justified. The assertion that the soil was acidic, low organic carbon, K, Ca and Mg was in accordance with Ayeni *et al.*'s (2022) findings that most southwestern soils especially Ondo State where this experiment was sited have low nutrients content. This finding is also in line with the work of Ayeni and Akinbani (2015) who found that Adeyemi College farm was low in soil nutrients and needed additional fertilizer to supply the deficient nutrients to the soil. Lim and Zahara (2008) affirmed that empty palm bunch comprises N, P, K and Mg. The presence of N, P, K, Ca and Mg and high pH of the kola, cocoa and empty oil palm bunch ashes are consistent with the observation of Ajayi *et al*. (2007) who performed experiment on comparative effects of cocoa pod husk and oil palm bunch ash on nutrient uptake, growth and dry matter yield of cocoa (*Theobroma cacao*) in Ibadan, southwest Nigeria. Application of 6 *g* KPHA and 6 *g* EPBA seem to have better performance in terms of plant parameters compared with other treatments applied. Highest level of the plant residues performed better than the mineral fertilizers under study. This might be as a result of the more plant nutrients embedded in plant residues than NPK, urea, potash fertilizer and CAN fertilizers. This also shows that the native soil was deficient in nutrients that were not present in NPK 20:10:10, urea, potash and CAN fertilizers. The seedlings that were fertilized with burnt plant residues might have enjoyed balanced nutrition more than the seedlings fertilized with mineral fertilizers. Conversely, relative to NPK fertilizer and CPHA, OPBA applied at the rate of 4 *g* 900-g^{-1} soil recorded significantly ($p < 0.05$) higher leaf K, Ca and Mg content, respectively. Application of NPK and urea fertilizers were found to increase the growth of oil palm seedlings. This observation, which most likely was in response to N due to these fertilizers (Ugwu *et al*., 2020; Umezinwa *et al*., 2020), is in line with Sodimu *et al.* (2022) on the positive effect of urea fertilizer on growth of African rose wood (*Pterocarpus erinaceous* Poir) seedlings in Kaduna State. Najihah *et al*. (2019) recommended 22, 22, and 40 *g* plant^{-1} of N, P_2O_5 and K_2O for good vegetative growth in oil seedlings. Oil palm at its early stage requires N for photosynthesis and growth, P for proper seed germination, root formation and energy transfer, while K is required by oil palm seedlings for proper stomata function as well as the transport of the assimilates, enzymatic reactions and oil formation. Olorunfemi *et al.* (2014) observed that cocoa pod ash and oil palm bunch ash significantly increased the growth parameters considered in cocoa seedlings in the experiment performed on comparative effects of

cocoa pod husk and oil palm bunch ash on nutrient uptake, growth and dry matter yield of cocoa (*Theobroma cacao*) in Ibadan, southwest Nigeria. The N content in kola pod husk ash was low and the C/N rate was also low. Phosphorus and calcium were low while potassium and magnesium were high. This analysis is in line with the report of Ayeni *et al*. (2008a, b) that ash contain small amount of nitrogen and high amount of potassium and magnesium. The low C/N ratio of the kola pod husk would enhance early mineralization of plant nutrients. The presence of N, P, K and Mg in the kola pod husk indicates that it is suitable to serve as fertilizers. The high cations especially K and Mg shows that kola pod husk could also serve as liming material to reduce soil acidity. Rosenani *et al.* (2016) observed that the use of oil palm wastes in the nursery as components of growing medium for oil palm seedlings seems to help in production of healthy seedlings that will produce optimum oil palm produce. The oil palm empty fruit bunch (EFB) could be used for transplanted palms as mulch and could also serve as nutrient source. Surya *et al*. (2019) affirmed that addition of composted agricultural waste improved root growth of oil palm seedlings while Wilson *et al*. (2001) affirmed that increases in nutrients uptake lead to increases in root growth. Ike (2008) noted a reduction in leaf area of *Arachis hypogea* when high concentration of palm bunch ash was added to the soil while lower concentrations were found to have a promotory effect. During burning, the OC and N content of agro-wastes tend to vaporize into the atmosphere thus, causing low OC and N content. The plant residues used in this research helped to increase dry matter of oil palm seedlings. This observation is in line with Petrus *et al.* (2010) in the experiment conducted to determine the effect of K-N humates on dry matter production and nutrient use efficiency of maize in Sarawak, Malaysia. The presence of N, P, K and Mg in the oil palm bunch ash indicates that it is suitable to serve as fertilizer. The high cations especially K and Ca showed that empty palm bunch ash could also serve as a liming material. The increase in soil pH as a result of application of cocoa pod husk ash, kola pod husk ash and empty palm bunch ash is in line with the experiment conducted by Ayeni *et al*. (2008a, b) and Nwite et al. (2011a, b) which showed that ash could be used to ameliorate soil acidity. The increase in soil Fe, Cu, Zn in CAN, MOP and NPK is an indication that they are acidic because micro-nutrients are known to increase soil acidity. Application of NPK fertilizer was found to increase soil total N and P. These increases in soil N and P due to NPK are contrary to the observation made by Umeugokwe *et al*. (2021), but not the ones by Nwite *et al*. (2013), Okebalama *et al*. (2022) and Ndzeshala *et al*. (2023).

CONCLUSION

Experiment was conducted at Adeyemi Federal University of Education to evaluate the effect of types of ash in improving growth performance, nutrients uptake of oil palm seedlings and soil chemical properties. Empty palm bunch ash, cocoa pod husk ash and kola pod husk were used as organic fertilizer while NPK 20:10:10, urea, CAN, muriate of potash and single super phosphate fertilizers. Application of empty palm bunch, cocoa pod husk ash and kola pod husk ash in raising oil palm seedlings in the nursery helps to increase the growth performance of oil palm seedling. Addition of 6 *g* of the plant residues recorded the highest growth parameters and biomass yield of oil palm seedlings. The results show that burnt plant residues serve as sources of nutrients for raising oil palm seedlings.

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