Effects of water extracts of neem (*Azadirachta indica* L.) leaf, wood ash and their mixture on soil chemical composition and growth and yield of plantain (*Musa sapientum* L)

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ABSTRACT

Aims; To evaluate the efficiency of water extracts of neem[Azadirachta indica L] leaf,wood ash and their 1;1 mixtures on soil chemical composition, growth and yield parameters of plantain (*Musa sapientum* L.) .

Place and duration; the experiment took place at Akure in the rainforet zone of Nigeria between 2006 and 2009 cropping seasons.

Study design; The field was laid out in a randomized complete block design and replicated three times.

Methodology;There were treatments with water extracts of neem leaf,wood ash and their mixtures applied at 833.3 Lha^{-}.,NPK15-15-15 fertilizer and a control [without any fertilizer or extract].Hybrid plantain suckers were planted at a spacing 2m x 2m and five plants of sprouted plantain suckers were randomly selected from each

treatment plot for data collection on growth, yield and soil chemical composition.The data were subjected to analysis of variance F- test and the means separated by Duncan Muliple Range Test at 5%

Result. The results showed that there were significant (P=0.05) increases in plantain growth ,yield parameters and soil chemical composition under different treatments.The mixtures of neem and wood ash extracts increased significantly [P= 0.05], the leaf area and stem girth of plantain by 49.24% and12% respectively compared to neem leaf extact. Also, the mixtures of the two extracts increased plantain bunch weight, finger weight, diameter, length and finger population by 39%, 41%,3%, 36% and 41.6% compared to neem leaf extract. When compared with NPK15-15-15, the treatment increased plantain bunch weight , fingers weight, diameter ,length and finger population by29.7%,31%, 6%, 8%, and 25% .Besides, the mixture of the water extracts of neem leaf and wood ash increased soil pH, organic matter , K, Ca, and Mg by 14%, 78%, 31%, 95.5% and 94% compared to NPK 15-15-15 fertilizer except N and P. The soil K/Ca, K/Mg and P/Mg ratios were higher under NPK 15-15-15 fertilizer than the liquid extracts signifying nutrient imbalance.

Conclusion; Mixture of water extracts of neem leaf and wood ash gave the best growth and yield parameters of plantain and this was due to its nutrients superiority compared to the other treatments.

KEY WORDS: Growth, improved soil chemical composition, low cost neem leaf, wood ash and 1;1 water extracts, Plantain (*Musa sapientum L)*, and **yield performances..**

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INTRODUCTION

Plantain (*Musa sapientum* L.) belongs to the family Musaceae and it originated from Malaysia. It is a herbaceous plant with short lived stalks which are corm like rhizomes usually 1.8m tall. Plantain is a food crop eaten by people in the West, East and Central Africa, it has become exportable crop which is consumed in Europe, America and Asia. Plantain has high iron content, minerals and vitamins which provide dietary needs of people for better health living and it is processed into different food stuff such as plantain flour, snacks and chips which are highly sought for in both local and international markets [1]. Therefore, there is an enormous increase in demand for the crop.

Total world production of the plantain and banana is estimated to be over 16 million metric tons out of which estimated 12 metric tons are produced in Africa annually. About 70 million people in African region are estimated to derive more than one quarter of their food energy requirements from plantain. [2]. In Nigeria, there are some yield reduction constraints such as decline in soil fertility, pests and diseases and weeds infestation that limit expansion [3].

Apart from medicinal value, neem leaf extract has many uses in plant protection and production. Neem leaf extract can inhibit soil nematodes (4). Products derived from neem leaf can act as powerful Insect Growth Regulation (IGR) which

reduce insect growth in crops and plants. Thus, neem products can be used as neem insecticide, neem pesticide, neem fumigant, neem fertilizer, neem manure, neem compost, neem urea coating agent and neem soil conditioner [5], [6].Neem seed extracts can reduce nitrification [7] of applied ammonium sulphate fertilizers and leaching loss of nitrogen. Pot experiments showed that neem extract could increase the use efficiency of chemical nitrogen significantly in soils [8].

In Bangladesh, wood ash is regularly used in banana plantations in terrace areas. Farmers say wood ash prevents diseases and improves water use efficiency. Wood ash is a good source of potash and lime; it also improves the pH of acidic soils in a manner similar to agricultural lime [9]. Wood ash had long been regarded as a source of potassium for plant growth (1-13% K by weight) but it also contains appreciable quantities of Ca (20-30%), P (0.3 0.4%), Mg (1- 3%) and smaller amounts of S, Mn, Fe, B, Cu and Zn [10].

Despite the economic importance of plantain to the nation, it is to note that maximum yields of the crop have not been attained. This is because of the continuous cultivation on the same piece of land without fertilizer application which has led to decline in soil fertility [11]. Besides, the present hectrage of plantain is very low because of subsistence farming and poor agronomic knowledge on the part of farmers.

Efforts aimed at improving the yield and increasing the soil fertility led to the uses of inorganic fertilizers but their use are limited by high cost especially by poor farmers and the destruction of soil properties on continuous use [12].Further attempts to find substitute for the use of chemical fertilizers led to the use of solid organic fertilizers such as poultry, goat, pig and cattle manures to achieve sustainable

production but the problems of bulkiness and difficulty in the transportation of such materials affected their adoption by farmers [13].

In view of the above facts, water extracts of wood ash, neem leaf and mixed neem leaf and wood ash were applied at present to grow plantain. Except the works of [14], [15] and [16] on the use of neem leaf and wood ash extracts to control pests in maize and cowpeas and as source of fertilizers, there is scarcity of research information on the uses of water extracts of neem leaf and their mixtures on the growth and yield parameters of plantain.

The objectives of this study are to

i. Determine the effects of water extracts of wood ash, neem leaf + wood ash on the growth and yield parameter of plantain.

ii. To determine the effect of the extracts on the soil chemical composition after 16 months of planting plantain.

2.0 MATERIALS AND METHODS

2.1 Site description

A field experiment to evaluate the effects of neem leaf extract , wood ash extract and mixed extracts of neem leaf and wood ash on plantain in the rainforest zone of Akure, Nigeria was conducted during 2006-2009.

The soil is sandy clay loam, skeletal, kaolintic, isohyperthermic oxic paleustalf (Alfisol) [17] The annual rainfall is between 1100 and 1500mm while the temperature ranged between 29- 32°c

2.2 Collection and analysis of the extracts

Wood ash and neem leaf were collected from the cassava processing unit and neem leaf plantation in Federal College of Agriculture, Akure while the NPK 15-15-15 fertilizer was purchased from Ondo State Agricultural Input Supply Agency. The plantain suckers were collected from the Nigeria Institute for Agricultural Research, Ibadan.

The preparation of neem leaf extract was done by weighing 10 kg of fresh leaves, chopped into bits using a knife, immersed in a plastic container containing 50 litres of water, kept under a shade and properly covered. The solution was stirred every three days to allow proper leaching of the nutrients into the water until the 14th day. Thereafter, the leaf were carefully removed using a sieve of 2mm to obtain clean neem leaf extract and diluted at a ratio of 1:1 to reduce the concentration of extracts as well as preventing scorching of the plants. The application of the extracts is at 3L per plot [833.3 Lha^{-1}]' wood ash extract was prepared by weighing 10kg of sieved wood ash into 50 litres of water in a plastic container and thoroughly stirred with paddle every three days to enhance proper leaching of nutrients. This continued until the 14th day of setting up the experiment and the suspension was properly sieved to obtain clear wood ash extracts.

The wood ash extract was also diluted at a ratio of 1:1 with water to reduce the concentration and applied at 3L per plot. The remnants of wood ash solid components was properly disposed to prevent contamination of the environment.

Mixed water extract of neem leaf and wood ash was prepared by taking 50% of undiluted neem leaf extract and 50% of undiluted wood ash by volume,diluted at a ratio of 1:1 with water and applied at 3L per plot while the NPK 15-15-15 fertilizer

was applied at 300 kgha^{-1}. 5ml each of the filtered extracts of neem leaf, wood ash and mixed neem leaf + wood ash was analyzed for %N using microkjedahl method [18] while soluble P, K, Ca and Mg contents were determined [19].

TABLE 1: <u>The chemical analysis of the extracts used for the experiment</u>

Treatments	N (%)	P (%)	K (%)	Ca (%)	Mg (%)	Quantity applied per plot (36m^2)	Quantity applied Per hectare
Neem leaf extract	3.56	0.83	1.67	0.77	0.75	3L	833.3L
Wood ash extract	0.15	0.53	2.60	15.00	1.00	3L	833.3L
Mixed neem leaf + wood ash extract	3.69	1.10	3.20	15.66	1.53	3L	833.3L

Table 1 presents the data on chemical composition of the extracts used for the experiment. Mixed water extract of neem leaf and wood ash had the highest values of % N, P, K, Ca and Mg compared to wood ash and neem leaf extracts (sole forms). The sole form of neem leaf had better values of % N and P than wood ash extract while the wood ash extract had higher values of % K, Ca and Mg than the neem leaf.

TABLE 2: Total amount of nutrients kgha^{-1} by each extract and NPK 15-15-15 fertilizer

Treatments	N	P	K	Ca	Mg
	Total kgha^{-1}				
Neem leaf extract	148.3	34.6	69.6	32.08	31.3
Wood ash extract	6.3	22.9	108.3	625.0	41.7
Mixed neem leaf + wood ash extract	153.7	45.8	133.3	625.5	63.8
NPK 15-15-15	45.0	45.0	45.0	0.2	0.1

The amount of nutrients [total kg/nutrient] supplied by each extract; mixed neem leaf + wood ash, neem leaf, wood ash and NPK 15-15-15 fertilizer is also presented in Table 2. More nutrients were supplied by the extracts particularly the mixed extract of neem leaf+ wood ash than the NPK 15-15-15 and control treatments.

The quantities of nutrients supplied by the extracts were adequate for sustaining growth and yield of plantain in the field as reflected in the soil chemical composition after harvest of plantain.

2.3 Field experiment

The land was cleared, ploughed and harrowed, divided into plots and each plot size is 6m X 6m ($36m^2$). Hybrid plantain suckers treated with nemagon(a.i1, 2 Dibromo-3-chloropropane) to control nematode were planted in early July, 2006 at a spacing of 2m X 2m.

There were five treatments namely: neem leaf extract, wood ash extract, mixed extract of neem leaf + wood ash applied at 3 litres/$36m^2$ plot, NPK 15-15-15 fertilizer applied at 300 $kgha^{-1}$ and a control treatment (no fertilizer nor extract), replicated three times and arranged in a randomized complete block design.

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Weeding operation was first done after three weeks of planting and continued at three weeks interval until harvest. Five plants of sprouted plantain suckers were sampled in each plot on which parameters for plant height (cm), leaf area (cm^2), stem girth (cm) and leaf population or number were taken every week starting from 2 weeks after establishment and this continued till 20 weeks after establishment.

The plantain started bearing inflorescence between 10 12 months after planting and the first harvest for matured plantain bunches was done at 15th month after establishment (November, 2007) and continued till early 2008. The following yield parameters were taken weight of plantain fingers, length of fingers (cm) plantain fingers diameter and plantain finger population. After harvesting, the plantain plots were properly weeded and the growth continued till the second harvest in late October, 2008 and April 2009.

Necessary agronomic practices such as propping up the plantain with sticks to prevent being fallen off during storms in early year, also, the plants were sprayed with Avesthrin (Cypermethrin 10EC at 10 ml/10 Litres of water) to prevent insect attack on the leaves.

2.4 Soil collection and analysis

Thirty core samples were collected randomly from 0-15cm depth on the site using soil auger, mixed thoroughly and the bulk sample was taken to the laboratory, air-dried and sieved to pass through a 2mm screen for chemical analysis.

The soil pH (1:1 soil:water) and (1:2 soil:0.01M $CaCl_2$) solution was determined by using a glass calomel electrode system[20] while organic matter was determined by the wet oxidation chromic acid digestion[21]. The total nitrogen was determined by the microkjedahl method [19] while available soil phosphorus (P) was extracted by the Bray P-1 extractant and measured by the Murphy blue colouration and determined on a spectronic 20 spectrophotometer at 882nm[22]. Exchangeable soil K, Ca and Ma were extracted with 1M NH_4OACAmmonium acetate] pH 7 solution.The K, Ca and Na contents were determined with flame photometer while Mg was determined with an atomic absorption spectrophotometer [AAS] [23].

The soil exchangeable acidity [H^+ and Al^{3+}] were determined using 0.01M HCL extractant and titrated with 0.01M NaOH[24] while the micronutrients (Mn, Cu, Fe and Zn) were extracted with 0.1MHCl [25]. The mechanical analysis of the soil % silt, % clay and % sand textural determination was done by the hydrometer method [26]. The soil bulk density was determined by core method as described by [27].

After the experiment, soil samples were taken from each plot, air dried, sieved with 2mm sieve, and analyzed for soil pH, organic matter, total N, available P, exchangeable K, Ca and Mg as described ear The soil properties before application of the treatments (initial soil fertility) were presented in Table 3. According to the established critical levels for soil in South West Nigeria, the soil is acidic pH 5.80 and low in soil organic matter compared to critical levels of 3% (

[28]

. The soil nitrogen (%N) is 0.07 which was less than 0.15% total nitrogen considered as optimum for crops [29]. The soil available P is 5.10 $mgkg^{1}$ considered as adequate for crop production [28].

Exchangeable K, Ca, Mg and Na values were much lower than the critical level of 0.2 $mgkg^{-1}$ while the micronutrients were more than the established critical levels of 5 $mgkg^{-1}$ Fe, 1.0 mg/kg^{-1} Cu, 5.0 $mgkg^{-1}$ Mn and 3.0 $mgkg^{-1}$ Zn [30]. The soil bulk density was 1.60 mgm^{-3} while the soil textual class is sandy loam.

TABLE 3: Soil properties before planting plantain

Particulars	Values	Methods
Soil pH (H_20)	5.8	Glass calomel electrode system (1)
Soil pH (0.01M $CaCl_2$)	5.3	
Organic matter (%)	0.4	Wet oxidation chromic acid digestion (2)
Nitrogen (%)	0.1	Microkjedahl method (3)
Available P (mg/kg)	5.3	Bray P extractant (4)
Exchangeable Bases		1M $NH_4OACpH7$ (5)
K ($mmolkg^{-1}$)	0.1	
Ca^{2+}($mmolkg^{-1)}$	0.1	
Mg^{2+}($mmolkg^{-1)}$	0.1	
Exchangeable Acidity		0.01M HCL extractant (6) and titrated against 0.1M NaOH
H^+ ($mmolkg^{-1}$)	4.3	
Al^{3+}($mmolkg^{-1}$)	1.5	
Micronutrients		0.1M HCL extractant (7)
Fe ($mgkg^{1}$)	8.5	
Zn ($mgkg^{-1}$)	3.8	
Cu ($mgkg^{-1}$)	2.0	
Mn ($mgkg^{-1}$)	1.8	
Particle Size Analysis (Soil Texture)		Bouycous Hydrometer method (8)
Sand (%)	79.5	
Silt (%)	14.7	
Clay (%)	5.7	
Bulk density (Mgm^{-3})	1.6	
% Porosity	41.8	Core method (9)

2.5 Statistical analysis

Analysis of variance followed by Duncan Multiple Range Test was done according to [31].

3.0 RESULTS

3.1 Treatment effects on growth and yield parameters of plantain

There were significant increases *(P=0.05)* in the plant height, leaf area, leaf population/number and stem girth (Table 4) as well as plantain bunch weight, diameter of plantain fingers, length and population for two cropping years (Table 5) under different fertilizer extracts compared to the control treatment.

Among the leaf extracts, the mixed of neem leaf + wood ash had the highest values of plantain leaf area and stem girth while the neem leaf and wood ash extracts (sole forms) had the highest values of plant height and leaf population/number respectively. For example, mixed extract of neem leaf + wood ash treatment increased the leaf area and stem girth by 49.24% and 12% respectively compared to neem leaf extract.When compared with NPK 15-15-15 Fertilizer, the mixed extracts of neem leaf + wood ash treatment increased slightly plantain plant height and stem girth by 1.0%, 32.60%, 13.8% and 13.8% respectively.

In 2007/2008 cropping season, the mixed extract of neem leaf + wood ash treatment increased the plantain bunch weight, finger weight, diameter length and finger population significantly (P=0.05) compared to other extracts. For example, mixed extract of neem leaf + wood ash increased plantain bunch weight, finger weight, diameter, length of fruit and population by 29.7%, 31%, 6%, 8% and 25% respectively.

Generally, the plantain bunch weight, diameter and length of fingers increased significantly in 2008/2009 cropping season under the mixed extract of neem leaf + wood ash more than 2007/2008 except plantain finger population and weight of fingers.

TABLE 4: <u>Effect of the treatments on the growth parameters of plantain</u>

Treatments	plant height(cm)	Leaf area(cm^2)	leaf population/ number	Stem girth(cm)
Control	45.6a	1454.6a	4.6a	17.7a
Wood ash extract	81.3b	4790.6d	8.2cd	29.4bc
NPK 15-15-15	85.9bc	3601.5c	6.3b	28.4b
Neem leaf extract	91.2d	2712.8b	6.8b	28.1bc
Mixed neem leaf + wood ash extract	86.5c	5344.2e	7.3c	33.0d

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

Table 5: Effect of the treatments on the yield parameters of plantain

Treatments	Cropping year	Weight of plantain bunch (kgha^{-1})	Weight of plantain fingers (kgha^{-1})	Diameter of plantain fruit finger (cm)	Length of fruit finger (cm)	Plantain finger population
Control	Nov 2007	2722.7a	2221.6a	2.2a	10.9a	9.0a
Wood ash	/Mar 2008	11529.5c	10555.3d	6.5b	20.3dc	28.0cd
NPK15-15-15		12496.5d	11215.7d	6.4b	17.8b	27.0c
Neem leaf		10833.3b	9580.7b	6.6bc	18.6bc	21.0b
Mixed neem leaf + wood ash extract		17777.5d	16495.5e	6.8d	19.3d	36.0c
Control	Nov 2008	2752.7a	2220.6a	2.8a	13.6a	10.0a
Wood ash	/Mar 2009	11941.1c	10833.33c	6.9bc	29.8c	27.0d
NPK15-15-15		12080.0 d	10833.3c	5.8b	26.3b	26.0c
Neem leaf		9580.7 b	8611.0b	6.3d	27.8c	23.0b
Mixed neem leaf + wood ash extract		24166.0e	11944.1d	7.7d	28.3cd	29.0c

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

3.2 Treatment effects on soil properties after harvest of plantain

There were significant increases ($P<0.05$) in the total N, available P, exchangeable K,Ca, Mg and organic matter under different fertilizer extract compared to the control treatment after harvest of plantain (16 months after establishment) Table 6.

Mixed extract of neem leaf + wood ash treatment increased the soil organic matter, N, P, K, Ca and Mg by 16.00%, 15.7%, 19% and 16.9% compared to the neem

leaf extract. When compared with NPK 15-15-15 fertilizer, the mixed extract of neem leaf + wood ash increased soil pH, 0.M, K, Ca and Mg by 14%, 2.78%, 31%, 95.3% and 94% except N and P.

The NPK 15-15-15 fertilizer decreased significantly the soil Ca and Mg while the control treatment had the least values of the soil parameters (soil pH, O.M, N, P, K, Ca and Mg). The soil K/Ca, K/Mg and P/Mg ratios were 5:1, 6:1 and 346:1 respectively under NPK 15-15-15 Fertilizer compared to soil K/Ca 1:3, 1:2, 10:1 under mixed extract of neem leaf + wood ash respectively.

Table 6: <u>Effect of the treatments on soil properties after harvest of plantain</u>

Treatments	**Soil pH**	**0.M %**	**N %**	**P mgkg^{-1}**	**K mmolkg^{-1}**	**Ca mmolkg^{-1}**	**Mg mmolkg^{-1}**
Control	5.20a	0.28a	0.03a	1.60a	0.03a	0.03a	0.06a
Wood ash extract	6.60e	1.45c	0.06b	7.00cd	0.36cd	1.15d	0.75c
NPK15-15-15	5.36ab	0.37d	0.23d	11.73ab	0.29b	0.06ab	0.05a
Neem leaf extract	6.20c	1.4c	0.06b	6.83c	0.34c	0.85c	0.69b
Mixed neem leaf + wood ash extract	6.24d	1.68d	0.08c	8.10e	0.42e	1.29e	0.83de

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

4.0 DISCUSSION

The fact that NPK 15-15-15 fertilizer improved the vegetative growth parameters such as plant height, leaf area, leaf population of plantain is consistent with its better soil N and P nutrients which are made much more readily available in mineralised forms than the organic forms in the neem leaf, wood ash extracts and mixed extract of neem leaf + wood ash.

The decrease in soil Ca and Mg in plots treated with NPK 15-15-15 fertilizer could be due to nutrient imbalances reflected in high K/Ca, K/Mg and P/Mg ratio which consequently affected uptake of Ca and Mg by plantain. In addition, the low values of soil organic matter, Ca and Mg under the NPK 15-15-15 fertilizer plot signified low base saturation, and the sandy loam texture also encouraged soil leaching activities and poor nutrients retention.

These observations could explain the reduction in values of plantain growth and yield parameters i.e. plant height, leaf area, stem girth, leaf population, weight of plantain bunches, weight of plantain fingers and fingers population under the NPK 15-15-15 fertilizer compared to the mixed extract of neem leaf + wood ash treatment which contained Ca, Mg and organic matter and subsequently increased soil fertility status for higher values of growth and yield parameters of plantain. (32) reported that continuous use of ammonium sulphate and NPK 15-15-15 Fertilizer decreased soil pH , K and macronutrients in okra, also (33) reported that arbitrary use of inorganic fertilizers resulted into signs of toxicities, poor yield responses and deterioration of soil properties in okra.

The performance of neem leaf extract in improving the growth and yield parameters of plantain could be traced to its high N, P, K, Ca and Mg nutrients

supplied to the soil which subsequently increased the soil organic matter, total N, available P, exchangeable K, Ca and Mg.

This also reflected in the increased values of the plant height, leaf area, stem girth, leaf population, plantain bunch weight, fingers weight, length, diameter and population. The finding was also supported by [8] who reported that neem seed extract enhanced the nitrogen use efficiency in soils as well as increasing the yield of crops. Also, [34] also reported the use of neem leaf extract increased soil nutrients, growth and yield parameters of tomato.

In addition, the moderate potassium content of neem leaf extract also contributed to better performance of plantain yield parameters and this was supported by [35] who reported the vital role of potassium in crop production.

The wood ash extract increased the values of plantain bunch weight, weight of fingers, diameter, length and finger population more than neem leaf and this could be traced to its very high K, Ca and Mg nutrients which subsequently increased the soil organic matter, K, Ca and Mg for uptake by plantain. This finding was supported by [36] who reported that wood ash is a good source of potash and lime which encouraged the growth and yield of plantain.

The increase in soil pH under wood ash extract compared to others was traced to its high K, Ca and Mg and could be effective as a liming material [37] unlike the NPK 15-15-15 fertilizer which with the continuous use could decrease soil pH. The soil pH been reported to influence nutrient uptake and availability. [38] reported that oil palm bunch ash, wood ash and cocoa pod husk improved soil K, Ca and Mg

nutrients and corrected soil acidity in an Alfisol grown to coffee and maize. [39] also reported that industrial wood ash was a good soil amendment for crop production.

The highest values of plantain bunch weight, weight of fingers, diameter of finger, length of fingers and finger population under the mixed extract of neem leaf + wood ash treatment could be due to the fact that it had the combined nutrient superiority of P, K, Ca Mg and N compared to neem leaf and wood ash extracts applied in sole forms. Therefore, the positive impact of extract of neem leaf + wood ash also reflected in the increase in soil pH, organic matter, N, P, K, Ca and Mg and the subsequent uptake by the plantain.

Hence, the impact of the mixed extract on the soil properties has been responsible for high yield parameters, plantain bunch weight, finger weight, diameter and length of fingers and finger population which further signified higher economic returns, food security and profitability for plantain farmers as well as providing raw materials to establish plantain flour, chips and biscuit industries. It is believed that this would promote plantain values chain development for export trade.

The observation was supported by [34] who reported superior performance of mixed extract of neem leaf + wood ash treatment in maize and water melon intercrop. Besides, the uptake of nutrients (N, P, K, Ca and Mg) in a liquid form from the mixed extract of neem leaf + wood ash could also be responsible for better plantain yield performance over the solid organic fertilizers which must be mineralized with adequate moisture before uptake by plant roots. Also, it has residual values which would have contributed to plantain bunch weight in the 2ndcropping year which NPK 15-15-15 fertilizer did not possess for subsequent cropping.

The poor growth and yield performance of plantain in the control treatment was consistent with the fact that the soil was very low in nutrient contents and this observation was supported by [13] who reported poor growth and yield responses of crops in soils that are not fertilized. The lowest values of soil N, P, K, Ca and Mg in the control treatment were a reflection of poor soil fertility status, hence, there is need to ensure fertilization of soils for bumper crop productivities in the tropical region where soils are low in organic matter, K, Ca, Mg and low soil pH [12].

In term of nutritional status, plantain has high iron, minerals and vitamins contents which helped to build up both physiological and metabolic activities in the body when consumed by people. This will reduce money spent on purchase and consumption of iron and vitamins based drugs and this observation was in line with meeting millennium development goals (MDGs) in food security and sound health for people in the world.

5.0 CONCLUSION

It could be concluded from the research work that mixed extract of neem leaf + wood ash treatment gave the highest values of plantain growth and yield parameters and also improved the soil nutrients (soil N, P, K, Ca, Mg and organic matter) compared to NPK 15-15-15 fertilizer, neem leaf and wood ash extracts (sole forms) respectively. It is recommended that for better performance of plantain bunch weight, finger weight, finger diameter and length, growth parameters and improvement of soil fertility status, application of mixed extract of neem leaf + wood ash at 833.3Lha^{-1} is appropriate.

Hence, the use of mixed extract of neem leaf + wood ash could substitute for 300 $kgha^{-1}$ of NPK 15-15-15 Fertilizer and it also reduced the problems of high cost of purchasing the inorganic fertilizer as well as solving problems of bulkiness and difficulty in the transportation of solid organic waste. Finally, it will help to prevent environmental pollution and deterioration of soil properties associated with continuous use of inorganic fertilizers such as NPK 15-15-15 fertilizers.

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COMPETING INTERESTS

There is no competing interests exist.

AUTHORS' CONTRIBUTION

ETHICAL APPROVAL

The study is not against the public interest.