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Research Paper

On The Combined Utilization of Neem Leaf Powder and Wood Ash in Acidic Soil Remediation in the Southeast of Nigeria

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Abstract— A key barrier to agricultural productivity is soil fertility, particularly in tropical regions like the southeast of Nigeria with their typical acidic soil. These soils' key traits are their low pH, low amounts of organic matter, deficit in Ca, Mg, P, or Mo, toxicity from Al or Mn, or both, and extremely poor rates of mineralization and nitrification. According to research, applying lime to soil is often advised to reduce soil acidity. Low-income farmers in the tropics cannot afford it, though. In an effort to address this issue, other options have proven effective, including the use of organic waste materials (compost), which is less expensive for low-income farmers, and perhaps harmful to a sustainable ecosystem. Lime, nutrients, and trace elements may be found in wood ash. The use of wood ash as an additional fertilizer is possible. On the other hand, applying neem leaf powder to crops has the obvious benefit of improving the crops' access to nitrogen, phosphorus, and potassium. It has been determined that adding wood ash to organic substances like neem powder at the correct application rate will increase the soil's fertility. Combining these two substances may help tropical agricultural soils improve their acidity and base deficiency issues as well as increase their soil microbial population.

Keywords— Soils, neem leaf powder, wood ash, remediation, utilization, acidity, mineralization.

1. Introduction

Botanicals are substances or byproducts of plants, according to [24] and [25] who studied the neem biopesticide use and problems in Central Northern Nigeria. Products made from plants that are prized for their pest-controlling, therapeutic, or medical characteristics. Whole fresh plants, isolated bioactive phytochemicals, or their formulations that are effective against infections and pests are all examples of phytopesticide materials. These organic insecticides may be made into fresh dried goods, liquid extracts, powders, cakes, or tiny porous bags and are renewable. The usage of unformulated or prepared bioactive plant pesticide in Nigeria has been documented by a number of scientists and farmers [25].

Neem (*Azadirachta indica* A. Juss Fam. Meliaceae) is a tree that has long been useful to the people who live in the center northern region of Nigeria. It may be used in a variety of ways, including for medicinal purposes, as shade trees, and the management of home and agriculture pests. It is also a raw material for soap and charcoal production. Its use for protection of crops and homes against pests and pathogens in the area reviewed is linked to their folklores and tradition [25].

Botanical pesticides are easy to prepare, locally renewable, easy to use and safe for the environment [34]. Potential of Neem (*Azadiracta indica* A. Juss) biopesticides for sustainable pest and disease management in Nigeria. [34] investigating the use of wood ash as a fertilizer to reduce the use of mineral fertilizers to improve maize (*Zea mays* L.) performance as measured by chlorophyll content and grain. estimated yield that wood ash from inorganic and organic residues of wood burning was found to be a good source of potassium, phosphorus, magnesium, calcium and trace elements [34]. Burning Sesbenia tree and adding ash to soil significantly increased maize grain yield in ICRAF in 1996, while application of ash to young maize plants significantly increased maize yield [34]. The increase in corn yield caused by the incineration of ash waste corresponds to an increase in the amount of phosphorus in the soil. Previous studies have shown that wood ash has the same liming effect as commercial lime, and several studies comparing traditional limestone and wood ash have confirmed that wood ash produces better plant growth responses than limestone because it contains additional nutrients. contains ash [34] The purpose of this review was to investigate the use of neem leaf powder-wood ash formulation in organic pest control and acid soil remediation.

1.1 Justification of the study

The world population is predicted to reach approximately 8.5 billion in 2030 according to UNPD in 2015. This has raised concerns in many economies around the world, including

Nigeria. This population growth means that more resources are needed to meet the food needs of the growing population. Food security is an important goal for the poor, especially those living in sub-Saharan Africa. However, agriculture can provide a large part of these resources (food, feed, fiber, etc.) in a huge way, thus ensuring food security. In Nigeria and especially in Cross River State, agriculture is the main source of livelihood for most people, especially those living in rural areas. it is a source of food and income. Due to this rapidly growing population, efforts must be increased to meet the growing demand for food sustainably through crop production. To ensure sustainable crop production for current and future generations, knowing our soil is essential. By ratifying the new UN Sustainable Development Goals (SDG) in 2016, the world committed to the ambitious task of ending hunger and promoting sustainable agriculture by 2030. In the process of achieving these goals, one important issue is soil. fertility or lack thereof. Poor soil fertility is a major yield limiting factor worldwide. Soil fertility can be understood as the ability of the soil to create the conditions necessary for plant growth and harvest. Two processes that reduce soil fertility are nutrient depletion and acidification. These processes are often intensified in densely populated, intensively farmed areas, mostly by small farmers with limited access to fertilizers and soil amendments. The use of wood ash is sometimes discussed in the search for agricultural strategies that preserve and improve soil fertility while being affordable to farmers with limited resources. Wood ash contains many important plant nutrients such as potassium (K) and phosphorus (P) and can be used as fertilizer.

The botanical pesticides are simple to prepare, locally renewable, user friendly and environmentally safe [34].

Potentials of biopesticides from neem tree (*Azadiracta indica* A. Juss) in sustainable pest and disease management in Nigeria. [34] while x-raying the utilization of wood ash as manure to reduce the use of mineral fertilizer for improved performance of maize (*Zea mays* L.) as measured in the chlorophyll content and grain yield opined that wood ash which is the inorganic and organic residue remaining after the In acidic soils, it also has the effect of increasing soil pH. This is very important in areas where the soil is old, weathered and prone to acidification. Such soils are abundant in much of sub-Saharan Africa. Neem leaf powder, on the other hand, contains nutrients such as nitrogen (N), phosphorus (P), and potassium (K). and may be used as an insecticide. Against this background, the objective of this study was to investigate the effects of wood ash combined with neem leaf powder on soil nutrients and soil pH in south-eastern Nigeria.

2. Review of Related Literature

2.0 Soil Acidification

Soil acidity can be understood as the ability of soil to act as an acid [34], and soil pH has a major influence on the availability of various soil nutrients by plants. give. There is no clear threshold at which soil is considered acidic. Acidic soils are soils with a pH below 5.5, whereas [20] that soil is considered weakly acidic when the pH is between 6.5 and 6.1, moderately acidic when the pH is between 6.0 and 5.5, strongly acidic when the pH is between 5.0 and 5.1, and extremely acidic when the pH is between 5.0 and 4.4. suggests. Acidification is estimated to affect more than 1.5 billion hectares worldwide [8], and other estimates suggest that acidic soils account for 40% of the world's total arable land area. suggested [9]. In Kenya, 13% of agricultural land is classified as acidic if the soil pH is less than 7 [12]. Natural processes and anthropogenic activities cause soil acidification. In soils with acidic parent materials, weathering processes in which silicate minerals are leached cause basic cations (Ca2, Mg2, Na, K) to be lost from the soil and replaced by protons (H) and aluminum. transformation will occur. Must be replaced (Al^3). In tropical and subtropical environments where precipitation exceeds evapotranspiration, this process occurs very rapidly, resulting in iron and aluminum oxides dominating the soil [30]; [19]. Base saturation (BS), the proportion of cation binding sites occupied by basic cations on the surface of soil particles (expressed as cation exchange capacity, CEC), is a parameter indicating soil acidity. In agricultural systems, removal of plant material contributes to and accelerates soil acidification [31]. Ammonia-based nitrogen fertilizers also cause acidification because the microbial nitrification process (conversion of ammonium, NH_4 to nitrate, NO3-) releases protons [31]. Two plant growth problems associated with soil acidification that reduce soil fertility are Al toxicity and P deficiency [15]. Under acidic conditions, the phytotoxic form of aluminum, Al_3, is present in soil solutions at levels that can adversely affect plant growth [22]; [6]. Al toxicity inhibits root development, reduces water and nutrient uptake, and reduces plant growth [12]. It is difficult to establish general thresholds for exchangeable Al3 concentration and Al^{3+} saturation, beyond which there is a significant negative impact on plant growth [22]. There is a big difference between seeds and soil. However, in many crops, the content of exchangeable Al^{3+} ions above 2.0 cmol/kg has a negative effect on growth [17]. Most maize varieties grown in Kenya require that the Al_3 saturation of the exchange complex be less than 20% [18]. Furthermore, in acidic soils, phosphate tends to form stable insoluble complexes with dissolved Al ions, making phosphorus unavailable to plants [2]; [13]. This is often referred to as phosphorus fixation or sorption, and in highly weathered acidic soils of the tropics, up to 70–90% of applied inorganic fertilizers can be fixej-biod [27]. Other plant growth limitations caused by soil acidity include K, Mg, Ca deficiencies, manganese (Mn) and iron (Fe) toxicity [5]; Baligar, 2008; [14].

Soil acidity can be understood as the ability of soil to act as an acid [32], and soil pH has a significant impact on the availability of various soil nutrients to plants. There is no clear threshold at which soil is considered acidic. [12] states that acidic soil is soil with a pH of 5.5 or less, with a pH of 6.5 to 6.1 considered weakly acidic, a pH of 6.0 to 5.5 moderately acidic, and a pH between 5.0 and 5.0 strongly acidic. I am writing. 5.1 and is very acidic with a pH of 5.0 to 4.4. Acidification is estimated to affect more than 1.5 billion hectares worldwide [8], and other estimates state that acid soils account for 40% of the world's total arable land area. [9] In Kenya, 13% of agricultural land is classified as acidic if the soil pH is less than 7 [12]. Natural processes and anthropogenic activities cause soil acidification. In soils composed of acidic matrix, basic cations (Ca^{2+}, Mg^{2+}, Na, K) are lost from the soil through the weathering process in which silicate minerals are leached and replaced by protons (H) and aluminum cans. Natural acidification occurs. Must be replaced (Al^{3+}). In tropical and subtropical environments where precipitation exceeds evapotranspiration, this process occurs very rapidly, resulting in iron and aluminum oxides dominating the soil [30]. [19]. Base saturation (BS), the proportion of cation binding sites occupied by basic cations on the surface of soil particles (expressed as cation exchange capacity, CEC), is a parameter that indicates soil acidity. In agricultural systems, removal of plant material contributes to and accelerates soil acidification [31]. Ammonia-based nitrogen fertilizers also cause acidification because the microbial nitrification process (conversion of ammonium, NH_4 to nitrate, NO_3) releases protons [31].

Two plant growth problems resulting from soil acidification, which makes the soil less fertile, are Al toxicity and P deficiency [6] Under acidic conditions, aluminum is present in the soil solution as phytotoxic Al^3 in amounts that can negatively affect plants. growth [22]; [6] Al toxicity inhibits root development, which reduces water and nutrient absorption and impairs plant growth [12]. It is difficult to determine a general threshold for changes in Al^{3+} concentration and Al^{3+} saturation, exceeding which plant growth will be significantly negatively affected [22] There are large differences between species and soils. However, for many crops, a concentration of exchangeable Al3 ions above 2.0 12 cmol/kg has a negative effect on growth [17]. For example, in most maize varieties grown in Kenya, the Al3 saturation in the exchange complex is less than 20% [18].

Furthermore, in acidic soils, phosphates tend to form stable insoluble complexes with dissolved Al ions, making P unavailable to plants [2]; [13]. This is often referred to as P fixation or absorption, and in the tropics, highly weathered acidic soils can bind up to 70–90% of applied inorganic fertilizers [27]. Plant growth limitations due to soil acidity also include e.g. K, Mg and Ca deficiencies and manganese (Mn) and iron (Fe) toxicity [5]; [14].

Organic resources such as high biomass producing plants are needed to reduce soil fertility in a continuous cropping system [25]. The use of plant biomass to supplement soil fertility also requires identification of species present near the farm to reduce labor costs. Such plant species should have the ability to increase phosphorus availability to crops because organic inputs are low in phosphorus. The plant material must be able to produce large amounts of mineral nitrogen before the crop can rapidly take up nitrogen. This means distributing large quantities of plant material that may not be available. This is an obvious advantage when using neem in cultivation, as stated above [26].

The parts of neem plant used in insecticidal preparations are stem, rhizome, leaves, flowers, fruits, seeds and kernels. Formulations can be in the form of powder (dust), crude oil extracts, ethanol extracts, aqueous extracts or a commercial formulation. However, this review tends to view neem powder as a compatible regimen with a combination of wood ash. [1] The size distribution and structure of soil particles were determined by the pipette method [16]. Soil bulk density was determined using the core method [24]. The maximum water holding capacity according to Wilke [33] was used to determine groundwater holding capacity. Soil pH and electrical conductivity (EC) were estimated using a soil to distilled water ratio of 1:1 w/v and 1:5 w/v, respectively. Organic carbon (C) in soil and neem leaf extract was determined using the Walkley and Black method [23], while total nitrogen (N) was determined using the micro-Kjeldahl method [3]. Inorganic nitrogen in soil and humus was determined by extraction in 2 M KCl and measured by the flow distillation method [29] with a micro-Kjeldahl distillation apparatus (Pro-Nitro S 4002851, JP Selecta, Barcelona, Soil phosphorus (P) was extracted with Bray-2 solution, while P in neem extract was obtained with nitric/chloric acid solution [21] and then determined by UV-Vis spectrophotometer (Specord250 plus, Analytik Jena, Germany), using a wavelength of 820 nm [11]. Extraction of cations, ie. potassium (K), calcium (Ca) and magnesium (Mg) from soil was done with 1 N NH4OAc at pH 7 [24], while cations from neem leaf extract were extracted with nitric acid. -for hydrochloric acid solution [21]. The cations were then determined using a flame atomic absorption spectrometer [7]. Cation exchange capacity (CEC) was determined by saturating soil negative surface charges with NH_4 obtained from 1 N NH_4OAc at pH 7. Ammonium ions were extracted from the adsorption sites with 10% NaCl and determined by the distillation method for further CEC calculation [24]. Extraction of soil exchangeable AI was performed with 1 M KCl and measured by a titrimetric method according to Pansu and Gautheyrou [24], modified using phenol red as an indicator instead of the commonly used phenolphthalein [4]. The determination of azadirachtin and nimbolide in the extract was evaluated by high-performance liquid chromatography following Stark and Walter [28].

3. Materials & method

3.1 Composition of neem powder

Neem plant materials were sun-dried or oven-dried, then ground into a fine powder in a mortar or electric mill and sieved through a fine sieve (diameter 0.25 mm) [1] into pastes or cakes [1].

3.2 Method of use

Neem powder, cake or granules can be applied to crops by hand in the same way as fertilization, ie. by sprinkling [1]. Alternatively, they are applied at planting with a basic NPK fertilizer and worked into the soil or spread around the growing plants using the circular method or side bands [17]. In storable products, the desired amount is measured on a measuring scale and distributed among the products (grains or nuts) and thoroughly mixed before storage. In the long run.

3.3 Dosage The amount used in the powder formula varies from less than 1 to 20 g/kg of grains/beans, but usually does not exceed 2% of the weight of the grains/nuts/beans [34]. Neem dust or paste can be used as a soil conditioner at 100–2000 kg/ha to control soil pests and diseases [34]. However, the concentrations of commercial dust preparations tested were based on manufacturers' recommendations.

4. Tables

Table 4.1 Nutrient Composition of neem leaf powder

Parameters	Value
Na (%)	0.35
K (%)	2.28
Ca (%)	0.60
Mg (%)	0.56
P (%)	1.20
N (%)	0.10
Moisture Content (%)	8.90
Acidity (mg kg)	0.18
pH in water	4.60
Azadirachtin (%)	6.90

Source: Proximate Analysis of Neem Powder, 2019

Table 4.1 above shows the percentage nutrient composition of the neem powder sample. From the table above, neem leaf powder contains 0.35% sodium, 2.28% potassium, 0.60% magnesium, 0.56% magnesium, 1.20% phosphorus and 0.10% nitrogen, moisture content is 8.90%, acidity 0.018%8. 6. %. This formula is rich in nutrients suitable for dissolving acidic soils at the recommended rate.

Table 4.2 Nutritive value of wood ash Parameters Wood ash

Table 4.2 Nutrient Composition of wood ash

Parameters	Wood ash
Mg (%)	1.95
Ca (%)	8.80
K(%)	3.57
P(%)	0.88
Organic Carbon(%)	18.50
Organic Nitrogen(%)	1.68
C-N Ratio	11.01
pH in water	10.10

Source: Proximate Analysis of wood ash, 2019

Table 4.2 above shows the percentage nutrient composition of sample of wood ash. From the above table wood ash is composed of 3.57% Potassium, 8.80% Calcium, 1.95% Magnesium, and 0.88% Phosphorus while the percentage organic carbon content is 18.50%, organic nitrogen content 1.68% and pH in water 10.10%. This composition shows a high organic carbon, nitrogen content and a high pH in water, suggestive of its suitability as an synthetic lime substitute for acidic soil remediation at a recommended rate.

5. Discussions

5.1 Using wood ash to improve soil fertility

Calcite limestone (CaCO3) is the lime material most commonly used to neutralize acidic soil. Burnt lime (slaked lime, calcium oxide or CaO) and hydrated lime (slaked lime, building lime, calcium hydroxide or $Ca(OH)_2$) are also used for scavenging in Europe. However, the higher cost of these materials limits their use in Western Canada [Agric-Facts]. Wood ash contains oxides and hydroxides of calcium, magnesium, potassium and, to a small extent, sodium, making wood ash similar in its effect to burnt or hydrated lime. Wood ash also contains many nutrients that were originally absorbed from the soil when the tree was growing, so it can improve crop yields by improving nutrition. In comparison, agricultural lime contains only minimal amounts of plant nutrients. Using wood ash as a liming material adds significant amounts of phosphorus, calcium, magnesium and potash (potassium) to the soil. Most agricultural lands, especially in Southeast Nigeria, are deficient in phosphorus and it is likely that improved crop yield after liming with wood ash may be due to increased availability of phosphorus [10].

5.2 Scattering of Ashes

When ash is used as a lime material, special attention should be paid to the following: • soil sampling • lime demand test • spread and add ash A thorough understanding of each factor is essential to get the most benefit from using wood ash.

5.2.1 Soil Sampling

The most commonly used sampling method is random sampling of homogeneous units in the field. This method is a traditional approach used in agriculture [10]. The field is divided into sampling units based on topographic location (ploughs, mid-slopes and hollows), differences in soil color, soil texture (sand, silt and clay in the soil) and percentage of organic matter. A synthetic soil sample (0-6 inches) is obtained from each unit by randomly sampling the soil from 15-20 locations [10]. Before sending the sample to an accredited laboratory for analysis, the pieces must be crushed, the sample must be mixed and a small sub-sample taken and air-dried. If the transport time is short, wet samples can be sent directly to the laboratory. Laboratory personnel dry these samples before analysis. Specimens 6 to 12 inches. and 12-24 inches. Depths should also be obtained to determine other plant production limits [10].

5.2.2. Analysis of wood ash requirement

If samples are supplied for lime requirements, the analysis must be performed using the incubation method. Alberta Environment recommends this method. Lime requirement is converted into ash recommendation with the following calculation [10].

Rate of ash required =

$$\frac{100}{\text{CCE of the ash}^{-a}} \times \frac{100}{100-\%H_2O^{-b}} \times \text{Lime requirement (tonnes per acre)}$$

Where:
-a CCE refers to the calcium carbonate equivalence of the wood ash. CCE is a measure of purity of the ash and is available from the generator of the wood ash.
-b Refers to per cent moisture in the ash and is available from the generator of the ash.
-c is the lime requirement as provided by the soil testing laboratory. If recommendations are made in metric measure, the appropriate corrections must be made if imperial measures are the preferred units.

Example: Lime requirement is 3 tonnes per acre.
CCE of ash is 65%
Per cent moisture is 5%

Therefore, the Rate of ash required =
$\frac{100}{65} \times \frac{100}{100^{-5}}$ × 3 tonnes per acre = 4.8 tonnes per acre
[10]

5.3 Application

Wood ash can be spread on any soil surface with a medium that evenly covers it [10]. Wood ash should be added to the soil. Fixing should be done over a reasonable period of time to minimize the generation of wind-induced dust or the removal of water flowing over the soil. Spreading ash on a permanent feed is not recommended because addition is not possible. Agricultural lime and to a lesser extent wood ash are relatively insoluble and therefore immobile. Land application without cultivation is minimal, so the benefits of ash are not realized when used in perennial forages [10]. Wood ash must not be spread in areas that may cause contamination of surface or ground water. Ash should not be spread within 50 meters of wells or standing water bodies, and should not be spread on frozen ground or in conditions where addition is not possible within three days. Wood ash is a very corrosive material. As with other agricultural chemicals, appropriate protective equipment should be worn 6. Conclusion and recommendation

Advantages of using wood ash.

In this regard, the advantages of applying wood ash to agricultural land are considered;
Tilth;
Soil fertility;
Weed control.

Tilth

Farmers often noticed an improvement in soil slope after liming, especially on soils with low organic matter (Luvisoline soil) or high sodium (Solonetz soil). Farmers have found that after liming, the soil is less susceptible to leaching, the power requirement for cultivation is lower, and water penetration is higher [10]. This improvement in soil slope is due to the ability of calcium to bind individual particles of sand, silt, and clay into stable soil materials. In more productive soils, such as the Black Soil Zone, organic matter is primarily responsible for maintaining a stable soil structure. Structurally stable soil is also well aerated, which is particularly important for optimal nitrogen fixation by legumes [10]. An Agriculture and Agri-Food Canada study shows that canola and barley yields increased when two soils near Valley View were limed to pH values of 5.5, 6.0, 6.5, 7.0 and 7.5. An increase in yield above pH 6.0 due to a decrease in soil acidity is not expected, as rapeseed and barley tolerate moderate acidity. Researchers have linked crop growth to improved soil fertility. This improvement in soil slope is believed to be a long-term benefit of liming.

Soil fertility

As trees grow, plant nutrients are absorbed from the soil and incorporated into the plant tissue. When fuel is burned, most of the nitrogen and sulfur are released into the atmosphere, while much of the phosphorus and potassium remain in the ash. Spreading ash on the soil also adds a significant amount of plant nutrients to the soil. Liming can improve soil fertility through several mechanisms. An increase in soil pH can increase the rate at which soil organic matter is decomposed by soil bacteria and thus accelerate the release of plant nutrients such as nitrogen. This temporary benefit can be observed two to three years after liming [10].

Weed control

The spread of weeds in agricultural land can occur when the competitiveness of the crop is reduced due to unfavourable plant growth conditions. Studies have shown that increasing soil fertility reduces the severity of infestation. The use of ash as a soil conditioner offers a unique opportunity to increase the competitiveness of crop growth by increasing soil pH and increasing soil fertility [10].

Recommendation

Based on the review of literature related to different topics, it can therefore be concluded that the combined use of neem leaf powder and wood ash in agricultural land can significantly increase crop productivity. Considering the above point, the combined use of neem leaf powder and wood ash in acidic soil remediation would undoubtedly create a new threshold to find sustainable solutions to reduce soil acidity, especially in the south-eastern part of Nigeria where soil acidity is prevalent. However, it is worth noting that both materials are also alkaline and can harm crops if overused or abused. Landowners must follow prescribed cost standards and use common sense when spreading.

Authors' Contributions

The author conceived the study, carried out the literature review, wrote the first draft of the manuscript. The author reviewed and edited the final version of the manuscript.

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Conflicts of Interest
The authors declare no conflict of interest.

References

[1]. Asogwa, E.U., Ndubuaku, J.A., Ugwu, J.A. and Awe, O.O. Prospects of botanical pesticides from neem, Azadirachta indica for routine protection of cocoa farms against the brown cocoa mirid Sahlbergella singularis in Nigeria. *Journal of Medicinal Plant Research,* Vol. **4** issue **1**, pp. **233-256**, **2010**

[2]. Bougnom, B.P., Knapp, B.A., Etoa, F-X., Insam, H. Possible use of wood ash and compost for improving acid tropical soils. In: Insam, H., and Knapp B.A (eds.) Recycling of biomass ashes. *Springer-Verlag Berlin Heidelberg Publisher*, Pp. **87 – 105, 2011**

[3]. Bremner, J.M.; Mulvaney, C.S. Nitrogen–Total. In Methods of Soil Analysis, Part 2: Chemical and Microbiological Propterties; Spark, D.L., Ed.; American Society of Agronomy, Inc.; *Soil Science Society of America,* Inc.: Madison, WI, USA, pp. **595–624, 1982**

[4]. Coscione, A.R.; de Andrade, J.C.; van Raij, B. Revisiting titration procedures for the determination of exchangeable acidity and exchangeable aluminum in soils. Commun. *Soil Sci. Plant Anal,* pp.**1973–1982, 1998**

[5]. Fageria, N.K. and Baligar V.C. Growth and nutrient concentrations of common bean, lowland rice, corn, soybean and wheat at different soil pH on an Inceptisol. *Journal of Plant Nutrition*, Vol. **22**, pp. **1495 – 1507, 1999**

[6]. Feng Ma, J., Ryan, P.R., Delhaize, E. Aluminium tolerance in plants and the complexing role of organic acids. *Trends in Plant Science*, Vol **6**, pp. **273 – 278, 2001**

[7]. Flame atomic absorption spectrometer (Flame AAS novAA® 350, Analytik Jena, Germany

[8]. Graham, P.H., and Vance, C.P. Legumes: Importance and constrains to greater use. *Plant physiology*, Vol **131**, pp. **872 – 877**, **2003.**

[9]. Haug, A., Foy, C.E. Molecular aspects of aluminium toxicity. *Critical Reviews in Plant Sciences*, Vol **1**, pp. **345 – 373**, **1984**

[10]. Jerome Lickacz, Wood ash- an alternative liming material for agricultural soils. In: Practical information for Alberta's Agriculture Industry. *Alberta Agriculture, Food and Rural Development*., Pulse and Oilseed Unit. Agdex **534-2, 2002.**

[11]. Jones, J.B. Laboratory Guide for Conducting Soil Tests and Plant Analysis; CRC Press: *Boca Raton*, FL, USA, pp.**101-200**, **2001**.

[12]. Kanyanjua, S.M., Ireri, L., Wambua, S., Nandwa, S.M. Acidic soils in Kenya: Constraints and remedial options. *Kari Technical Note,* pp. **11**. **2002**

[13]. Kisinyo, P.O., Opala, P.A., Gudu, S.O., Othieno, C.O., Okalebo, J.R., Palapala, V., Otinga, A.N. Recent advances towards understanding and managing Kenyan acid soils for improved crop production. *African journal of Agricultural Research*, Vol. **9**, pp. **297 – 2408**, **2014**

[14]. Kisinyo, P.O., Othieno, C.O., Gudu, S.O., Okalebo, J.R., Opala, P.A., Ng'etich, W.K., Nyambati, R.O., Ouma, E.O., Agalo, J.J., Kebeney, S.J., Too, E.J., Kisinyo, J.A., Opile, W.R. Immediate and residual effects of lime and phosphorus fertilizer on soil fertility and maize production on western Kenya. *Experimental Agriculture*, Vol. **50**, pp **128 – 143**, **2014**.

[15]. Kochian, L.V., Hoekenga, O.A., Pineros, M.A. How do crop plants tolerate acid soils? – Mechanisms of aluminium tolerance and phosphorus deficiency. *Annual Review of Plant Biology,* Vol. **55**, pp. **459 – 493**, **2004.**

[16]. Kroetsch, D.; Wang, C. Particle Size Distribution. In Soil Sampling and Methods of Analysis, 2nd ed.; Carter, M.R., Gregorich, E.G., Eds.; *Canadian Society of Soil Science*, CRC Press; Taylor & Francis Group: Boca Raton, FL, USA, pp. **713–725**, **2008**

[17]. Landon, J.R. Booker tropical soils manual: A handbook for soil survey and agricultural land evaluation in the tropics and subtropics. *John Wiley & Sons Inc*., New York, pp. **106 – 156**., **1984**

[18]. Ligeyo, D.O. Genetic analysis of maize (*Zea mays* L.) tolerance to aluminium toxicity and low phosphorus stress and development of synthetics for se in acid soils of western Kenya. *East African Agricultural and Forestry Journal,* Vol.**74** Issue **1-2**, pp.**11-16**, **2008.**

[19]. Mayer, R. Soil acidification and cycling of metal elements: cause-effect relationships with regard to forestry practices and climatic changes. *Agriculture, Ecosystems and Environment*, Vol. **67**, pp. **145 – 152**, **1998.**

[20]. McFerland, M.L., Haby, V.A., Redmon, L.A., Bade, D.H. Managing soil Acidity. In *Texas cooperative Extension*, Texas. pp. **112**, **2001**

[21]. Miller, R.O. Nitric-Perchloric Acid Wet Digestion in an Open Vessel. In Handbook of Reference Methods for Plant Analysis; Kalra, Y.P., Ed.; CRC Press: Boca Raton, FL, USA, pp. **57–61**. **1998**

[22]. Miyasaka, S.C., Hue, N.V., Dunn, M.A. Aluminium. In: Barker, A.V., Pilbeam, D.J. (eds.) *Handbook of plant nutrition*. CRC Press, Taylor and Francis Group. New York, pp. **439 – 497**, **2007**

[23]. Nelson, D.W.; Sommers, L.E. Total Carbon, Organic Carbon, and Organic Matter. In Methods of Soil Analysis, Part 2: Chemical and Microbiological Propterties; Spark, D.L., Ed.; *American Society of Agronomy*, Inc.; *Soil Science Society of America*, Inc.: Madison, WI, USA, pp. **539–579**, **1982**

[24]. Pansu, M.; Gautheyrou, J. Handbook of Soil Analysis: Mineralogical, Organic and Inorganic Methods; Springer: *Berlin/Heidelberg*, Germany, **2006**.

[25]. Salako E.A. "Plant protection for the resource-poor farmers". A keynote address at Nigerian Society for Plant Protection *In the Proceedings of the 30th Annual conference*. UNAAB. Abeokuta Sept. **1st-4th**, **2002**.

[26]. Salako, E. A., Anjorin, S. T., Garba, C. D., and Bamidele-Omolohunnu, E. B. A review of neem biopesticide utilization and challenges in Central Northern Nigeria. *African Journal of Biotechnology,* Vol. **7 (25)**, pp. **4758-4764**, **2008**.

[27]. Sanchez, P.A., and Salinas, G.J. Low-input technology for managing Oxisols and Utisols in tropical America. In: Cichy, A.K., Blair, M.W., Galeano Mendoza, C.H., Snapp, S.S., Kelly, J.D. (eds) Quantitative trait analysis of root architecture traits and low phosphorus tolerance in Andean bean population. *Crop science*, Vol **49**, pp. **59 – 68**, **1981**.

[28]. Stark, J.D.; Walter, J.F. Persistence of azadirachtin A and B in soil: Effects of temperature and microbial activity. *J. Environ. Sci. Health* B, Vol.**30**, pp.**685–698**, **1995**

[29]. Stevenson, F.J. Nitrogen–Inorganic Forms. In Methods of Soil Analysis, Part 2: Chemical and Microbiological Propterties; Spark, D.L., Ed.; American Society of Agronomy, Inc.; *Soil Science Society of America*, Inc.: Madison, WI, USA, pp. **643–698, 1982**

[30]. Sumner, M.E., and Noble A.D. *Soil acidification: the world story*. In: Rengel, Z. (ed.) Handbook of soil acidity. Marcel Dekker, New York, Vol.**27** pp.**12**, **2003**

[31]. Vieira, F.C.B., Bayer, C., Mietniczuk, J., Zanatta, J., Bissani, C.A. Long-term acidification of a Brazilian Acrisol as affected by no till cropping systems and nitrogen fertilizer. *Australian Journal of Soil Research*, Vol. **46**, pp. **17 – 26**, **2008.**

[32]. Vorob'eva, L.A., and Avdon'kin, A.A.Potential soil acidity: notions and parameters. *Eurasian soil science*, Vol. **39(4)**, pp. **377 – 386**, **2006**.

[33]. Wilke, B.M. Determination of Chemical and Soil Properties. In Manual for Soil Analysis—Monitoring and Assessing Soil Bioremediation; Margesin, R., Schinner, F., Eds.; *Springer: Heidelberg*, Germany, pp. **47–95**, **2005.**

[34]. Yar'adua, A.A, "Potentials of biopesticides from neem tree (*Azadiracta indica* A. Juss) in sustainable pest and disease management in Nigeria" In the Proceedings of the Medicinal plants in Agriculture. Proc. *Akure-Humbolt Kellog 3rd SAAT Annual Conference*, pp. **237-254**, **2006**.

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