

Research paper

**COMPARATIVE EVALUATION OF NEEM LEAF (*Azadirachta indica* L),
WOOD ASH AND MODIFIED NEEM LEAF EXTRACTS ON THE SOIL
CHEMICAL COMPOSITION, GROWTH AND YIELD OF PLANTAIN (*Musa
sapientum* L)**

BY

DR. EMMANUEL IBUKUNOLUWA MOYIN-JESU

**AGRONOMY DEPARTMENT,
FEDERAL COLLEGE OF AGRICULTURE
AKURE, ONDO- STATE, NIGERIA**

22 **ABSTRACT**

23 Two Field experiments were carried out simultaneously at Akure in the rainforest
24 of Nigeria between 2006 and 2009 to evaluate the efficiency of different organic liquid
25 extracts on the soil fertility, improvement growth and yield parameters of plantain (*Musa*
26 *sapientium* L).

27 Three liquid fertilizer treatments namely: neem leaf, wood ash extracts and
28 modified neem leaf extract were applied at 833.3 L/ha in addition, to 300kg/ha NPK 15-
29 15 fertilizer and a control (no fertilizer nor liquid fertilizer extract), replicated three times
30 and arranged in a randomized complete block design.

31 The results showed that there were significant ($p<0.05$) increases in the plantain plant
32 height, leaf area, stem girth, leaf population, weight of plantain bunches, fingers weight,
33 fingers diameter and population, soil N, P, K, Ca and Mg under the different fertilizer
34 treatments compared to the control treatment.

35 For the growth parameters, modified neem leaf extract increased significantly
36 ($p<0.05$) the leaf area and stem girth of plantain by 49.24% and 12% respectively
37 compared to neem leaf extracts. It also increased these growth parameters to neem leaf
38 compared to NPK fertilizer.

39 For yield performance of plantain, modified neem leaf extract increased the bunch
40 weight, finger weight, diameter, length and finger population by 39%, 41%, 3%, 36%
41 and 41.66% compared to neem leaf extract. Also, when compared with NPK 15-15-15
42 fertilizer, modified neem leaf increased plantain bunch weight, finger weight, diameter,
43 length and finger population by 29.7%, 31%, 6%, 8% and 25% respectively.

For soil chemical composition, modified neem leaf extract increased soil pH, 0.M, K, Ca and Mg by 14%, 78%, 31%, 95.5% and 94% compared to NPK 15-15 fertilizer except N and P. The soil K/Ca, M/Mg and P/Mg ratios were higher under NPK fertilizer than the liquid extracts signifying nutrient imbalance.

Modified neem leaf extract applied at 833.3 L/ha gave the best growth and yield parameters of plantain. This was due to its nutrient superiority compared to the other treatments.

Key words: Modified neem leaf, neem leaf, wood ash extracts, growth, yield parameters of plantain and soil fertility improvement.

INTRODUCTION

Plantain (*Musa sapientium* L) belongs to the family of Musaceae and it originated from Malaysia. It is herbaceous plant with short lived stalls which are corm like rhizomes usually 1.8m tall. Plantain is a food crop eaten by people in the West, East and Central Africa, interestingly; 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 higher productivity. 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 (**Wilson, 1986**). Therefore, there is an enormous increase in demand for the crop.

Despite the economic importance of plantain to the nation it is regrettable to note that the 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 **Agboola (1982)**. Besides, the present hectarage 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 use of inorganic fertility but their uses are limited by high cost of purchase especially by poor resource farmers and the destruction of soil properties on continuous use. **(Moyin-Jesu, 2007)**

Further attempts to find substitute for the use of chemical fertilizer 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. **(Moyin-Jesu and Atoyosoye 2002)**

In order to solve the above research problem as well as preserving the environment, there is need to explore the use of wood ash neem leaf and modified neem leaf extracts to grow crops. Except the works of **Ivbijaro (1983)**, **Moyin Jesu (2010)** and **Moyin-Jesu (2012)** 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 wood ash, neem leaf and modified extracts on the growth and yield parameters of plantain. A modified neem leaf extract is made up of 50% each of neem leaf and wood ash solution extracts.

The objectives of this study are to;

1. Determine the effect of modified neem leaf, neem leaf and wood ash extracts on the growth and yield parameters of plantain.
2. To determine the effect of the extracts on the soil chemical composition after one year of planting plantain.

MATERIALS AND METHODS

The two field experiments were simultaenously carried out at Akure in the rainforest zone of Nigeria between 2006 and 2009 to validate the results. The soil is sandy clay loam, skeletal, kaolintic, isohyporthermic oxic paleustalf (Alfisol). Soil Survey staff (1999). The annual rainfall is between 1100 and 1500mm while the temperature ranged between 29°C – 32°C per annum.

Soil sampling and analysis before planting

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 CaCl₂) solution was determined by using a glass calomel electrode system. **Crockford and Nowell (1956)** while organic matter was determined by the wet oxidation chromic acid digestion. **Walkley and Black (1934)**. The total nitrogen was determined by the microkjedahl method (AOAC, 1970) while available soil phosphorus (P) was extracted by the Bray P1 extractant and measured by the Murphy blue coloration and determined on a spectronic 20 at 882um

(**Murphy and Riley, 1962**). Soil K, Ca, Mg and Na were extracted with IM NH_4OAC pH 7 solutions. The K, Ca and Na contents were determined with flame photometer while Mg was determined with flame photometer an atomic absorption spectrophotometer. (**Jackson, 1958**).

The soil exchangeable acidity (H^+ and Al^{3+}) were determined using 0.01M HCl extracts and titrated with 0.1M NaOH (Mclean, 1965) while the micronutrients (Mn, Cu Fe and Zn) were extracted with 0.1MHCL (Ogunwale and Udo, 1978) and read on Perkin Elmer atomic absorption spectrophotometer. The mechanical analysis of the soil for texture determination was done by the hydrometer method (**Bouycous, 1951**).

Collection of the organic materials used

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

Procedures for preparation and application of the extracts used

The preparation of neem leaf extract was done by weighing 10kg of fresh neem 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 stored every three days to allow proper leaching of the nutrients in the leaves into the water until the

131 14th day. Thereafter, the leaves were carefully removed using a sieve of 2mm to obtain
132 clean neem leaf extract. It is diluted at a ratio of 1:1 to reduce the concentration of the
133 extract to prevent scorching of the plants, while the application of the extract is at 3 L
134 per plot.

135 Wood ash extract was prepared by weighing 10kg of sieved wood ash into 50litres
136 of water in a plastic, thoroughly, stirred with pebble every three days to enhance proper
137 leaching of nutrients. This continued until the 14th day of setting up the experiment. The
138 suspension was properly sieved to obtain clear suspension of the wood ash extracts. The
139 remnant of wood ash solid components was properly disposed off to prevent
140 environmental contamination. The liquid wood ash extract was also diluted at a ratio 1:1
141 with water to reduce the concentration and applied at 3L/ plot. The required quantities
142 were obtained by setting up the preparation of the neem leaf and wood ash extracts
143 simultaneously. Modified neem leaf extract was prepared by taking 50% of concentrated
144 neem leaf extract and 50% of concentrated solution of wood ash extract, mixed together
145 thoroughly, diluted at a ratio of 1:1 with water and applied at 3 L/ plot. Finally, NPK 15-
146 15 fertilizer was applied at 300kg/ha.

147

148 **Analysis of the organic extracts used**

149 5ml each of the filtered extracts of wood ash, neem leaf and modified neem leaf
150 extracts was analyzed for %N using microkjedahl method (**Jackson, 1964**) while P, K,
151 Ca, Mg contents were determined (**AOAC, 1970**).

152

153

154

155

156 Field experiment

157 The land was cleared, ploughed and harrowed, divided into plots and each plot
158 size is 6mX6m (36m²). Hybrid plantain suckers treated with nemagon, to control
159 nematode, were planted in early July 2006 at the spacing of 2mX2m.

160 There were five treatments namely: neem leaf extract, wood ash extract, modified
161 neem leaf extract applied at 3 litres/36m² plot, NPK 15-15 fertilizer applied at 300kg/ha
162 and a control treatment (no fertilizer extract), replicated three times and arranged in a
163 randomized complete block design.

164 Weeding operation was first done at three weeks after planting and continued at
165 three weeks interval until harvest. Five plants of sprouted plantain were sampled in each
166 plot on which the parameters for plant height (cm), leaf area (cm²), stem girth (cm) and
167 leaf population were taken every week starting from 2 weeks after establishment, this
168 continued till 20 weeks after establishment.

169 The plantain started bearing inflorescence between 10 – 12months after planting
170 and the first harvest for matured plantain bunches were done at 15th months after
171 establishment (November, 2007) and continued till early 2008. The following yield
172 parameters were taken, weight of plantain fingers (cm), length of fingers (cm) and
173 plantain fingers population.

174 After harvesting, the plantain plots were properly weeded and the growth
175 continued till the second harvest in late October, 2008 and April, 2009.

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

180 **Soil analysis after the experiment**

181 Soil samples were taken from each plot, air-dried, sieved with 2mm sieve,
182 analyzed for soil pH, 0.M, N, P, K, Ca and Mg as described earlier.

183

184 **Statistical analysis**

185 The data collected from the treatment effects of the extracts on the growth, yield
186 parameters and soil chemical composition of plantain were analyzed using the ANOVA
187 F-test technique and their means were separated and compared using the Duncan
188 Multiple Range Test (DMRT) at 5% level of significance (**Gomez and Gomez, 1984**).

189

190 **RESULTS**

191 **Initial soil fertility before planting**

192 The soil properties before treatments application were presented in Table 1.
193 According to the established critical levels for soils in South West Nigeria, the soil is
194 acidic pH 5.70 and low in soil organic matter component to critical levels of 3%
195 (**Agboola and Corey, 1973**). The soil Nitrogen (%N) is 0.07 which was less than 0.15%

total nitrogen considered as optimum for crops (**Sobulo and Osinnome, 1981**). The soil available P is 5.10mg/kg which less than 10 mg/kg P considered as adequate for crop production (**Agboola, 1982b**).

Exchangeable K, Ca, Mg and Na values were much lower than the critical level of 0.2mg/kg while the micronutrient values were more than the established critical levels of 5mg/kg Fe, 1.0mg/kg Cu, 5.0 mg/kg Mn and 3.0mg/kg Zn (**Adeoye, 1986**). The soil bulk density value was 1.6mgm⁻³ while the soil textural class is sandy loam.

Chemical analysis of the extracts used for the experiment

Table 2 presents the data on chemical composition of the treatments used for the experiments. Among the extracts, modified neem leaf extract 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. Wood ash extract had higher values of % K, Ca and Mg than neem leaf.

Effect of different organic treatment extracts on growth parameters of plantain

There were significant increases ($P<0.05$) in the plant height, leaf area, leaf population and stem girth of plantain under different treatments extracts compared to the control treatment (Table 3).

Among the leaf extracts, modified neem leaf extract had the highest values of plantain leaf area and stem girth while neem leaf extract and wood ash extract had the highest values of plant height and leaf population respectively. For example, modified

218 neem leaf extract increased the leaf area and stem girth of plantain by 49.24% and 12%
219 respectively compared to neem leaf extract,

220 When compared with NPK 15-15 fertilizer, modified neem leaf extract increased
221 slightly plantain plant height, leaf area, leaf population and stem girth by 1.0%, 32.60%,
222 13.8% and 13.8% respectively.

223

224 **Effect of different organic treatment extracts on the yield parameters of plantain**

225 There were significant increases ($P < 0.05$) in the plantain bunch weight, plantain
226 fingers, diameter of plantain fingers, length and population under different fertilizer
227 extracts compared to the control treatment (Table 4) under two cropping years.

228 In 2007/2008 cropping session, modified neem leaf extract increased the plantain
229 bunch, finger weight, diameter, length and finger population significantly ($P < 0.05$)
230 compared to other extracts. For example, modified neem leaf increased plantain bunch,
231 finger weight, diameter, length and finger population by 39%, 41%, 3%, 3.6% and 41.6%
232 compared to neem leaf extract.

233 When compared with NPK 15-15 fertilizer, modified neem leaf extract increased
234 plantain bunch weight, fingers weight, length of fruit fingers and population by 29.7%,
235 31%, 6%, 8% and 25% respectively.

236 Generally, the plantain bunch weight, diameter and length of fingers increased
237 significantly in 2008/2009 cropping season under modified neem leaf extract more than
238 2007/2008 except plantain finger population and weight of fingers.

239

240

241 **Effect of different organic fertilizer extracts on the soil chemical composition after**242 **16months of planting plantain**

243 There were significant increases ($P<0.05$) in the soil pH, N, P, K, Ca, Mg and 0.M
244 under different fertilizer solution extracts compared to the control treatment after
245 16months of planting plantain.

246 Modified neem leaf extract increased the soil 0.M, N, P, K, Ca and Mg by
247 16.00%, 15.7%, 19% and 16.9% compared to the neem leaf extract. When compared
248 with NPK 15-15 fertilizer, modified neem leaf extract increased soil pH, 0.M, K, Ca and
249 Mg by 14%, 2.78%, 31%, 95.3% and 94% except N and P.

250 The NPK fertilizer decreased significantly the soil Ca and Mg while the control
251 treatment had the least values of the soil parameters (Soil pH, 0.M, N, P, K, Ca and Mg).

252 The soil K/Ca, K/Mg and P/Mg ratios were 5:1, 6:1 and 346:1 respectively under
253 NPK 15-15-15 compared to soil K/Ca 1:3, 1:2 and 10:1 under modified neem leaf extract
254 respectively.

255

256

257 **DISCUSSION**

258 The poor growth and yield performance of plantain in the control treatment was
259 consistent with the fact that the soil was very low in nutrient contents. This observation
260 was supported by Moyin-Jesu and Atoyosoye (2002) and Agboola (1982) who reported
261 poor growth and yield responses of crop 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 better soil fertilization for bumper crop productivities in the tropical region when soils are low in organic matter, K, Ca, Mg and low soil pH (**Moyin-Jesu, 2007**).

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

The decrease in soil Ca and Mg nutrient in plots treated with NPK 15-15-15 fertilizer could be due to nutrient imbalance as reflected in high K/Ca, K/Mg and P/Mg ratios which consequently affected up take of Ca and Mg by plantain.

In addition, the low values of soil O.M, Ca and Mg under the NPK 15-15-15 fertilized plot signifying low base saturation and the sandy loam texture would encourage soil leaching activities. These observations could explain the reduction in values of plantain growth and yield parameters under NPK 15-15-15 fertilizer, plant height, leaf area, stem girth, leaf population, weight of plantain bunches, weight of plantain fingers, diameter of plantain fingers, length of plantain fingers and finger population compared to the modified neem leaf extract which contained high Ca, Mg and O.M contents and subsequently increased soil fertility status for higher growth and yield of plantain.

The highest values of plantain bunch weight, weight of fingers diameter of fingers, length of fingers and finger population under the modified neem leaf 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 the balanced nutrient composition of modified neem leaf extract has been responsible for high yield parameters of plantain and signified higher economic returns, food security and profitability for plantain farmers as well as providing raw materials to establish plantain flour, chips and industries. Hence, this would promote plantain value chain development for export.

This observation was supported by **Moyin-Jesu (2012)** who reported superior performance of modified neem leaf extract in maize and watermelon intercrop. Besides, the uptake of nutrients (N, P, K, Ca and Mg) in a liquid form from the modified neem leaf extract could also be responsible for better plantain yield performance over the solid organic fertilizers which must be mineralized with adequate soil moisture before uptake by plant roots. Also, it has residual value which would have contributed to plantain bunch weight in the 2nd cropping year. 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.

306 CONCLUSION AND RECOMMENDATION

307 It could be concluded from the research work that modified neem leaf
308 (Neem leaf and wood ash) extract gave the highest plantain growth and yield parameters
309 and also improved the soil nutrients; (soil N, P, K, Ca, Mg and 0.M) compared to NPK
310 fertilizer, neem leaf and wood ash extract (sole forms). It is recommended that for better
311 plantain bunch, finger weight, finger diameter and length, growth parameter and
312 improvement of soil fertility status, application of modified neem leaf extract at
313 833.3L/ha is appropriate.

314 Hence, the use of modified neem leaf extract could substitute for 300kg/ha of
315 NPK 15-15-15 fertilizer. It also reduced the problems of high cost of purchasing the
316 inorganic fertilizers as well as solving problems of bulkiness and difficulty in the
317 transportation of organic wastes. Finally, it will help to prevent environmental pollution
318 and deterioration of soil properties associated with continuous use of NPK 15-15-15
319 fertilizers.

320

321

322

323

324

325

326

327

328 **TABLE 1:**
 329 **Table 1: Soil properties before planting cabbage**

Soil Properties	VALUES
Soil pH (H ₂ O)	5.80
Soil pH (0.01M CaCl ₂)	5.32
Organic matter (%)	0.43
Nitrogen (%)	0.07
Available P (mg/kg)	5.26
Exchangeable Bases	
K (mmol/kg)	0.10
Ca ²⁺ (mmol/kg)	0.11
Mg ²⁺ (mmol/kg)	0.09
Exchangeable Acidity	
H ⁺ (mmol/kg)	4.30
Al ³⁺ (mmol/kg)	1.45
Micronutrients	
Fe (mg/kg)	8.50
Zn (mg/kg)	3.80
Cu (mg/kg)	2.00
Mn (mg/kg)	1.80
Particle Size Analysis (Soil Texture)	
Sand (%)	79.50
Silt (%)	14.70
Clay (%)	5.70
Bulk density (Mgm ⁻³)	1.60
% Porosity	41.81

330
 331 .
 332
 333
 334
 335

336

TABLE 2: The chemical composition of the treatment extracts

TREATMENTS	N %	P %	K %	Ca %	Mg %	Quantity applied/plot	Quantities applied/ ha
Neem leaf extract	3.56	0.83	1.67	0.77	0.75	3L/36m ²	833.3 L
Wood ash extract	0.15	0.53	2.60	15.00	1.00	3L/36m ²	833.3 L
Modified neem leaf extract	3.69	1.10	3.20	15.66	1.53	3L/36m ²	833.3 L

337

338

339 **TABLE 3: The growth parameters of plantain under different organic treatment**

340 **extracts**

Treatments	plant height(cm)	Leaf area(cm²)	leaf population	stem girth(cm)
Control	45.6a	1454.6a	4.6a	17.68a
Wood ash extract	81.3b	4790.59d	8.2cd	29.39bc
NPK 15-15-15	85.90bc	3601.51b	6.3b	28.41b
Neem leaf extract	91.20d	2712.81b	6.83b	28.08bc
Modified neem leaf extract	86.5c	5344.17e	7.31c	32.96d

341 Treatment means within each group followed by the same letters are not significantly

342 different from each other using Duncan Multiple Range test at 5% level.

343 **TABLE 4:**

Treatments	cropping year	weight of plantain bunch (kg/ha)	weight of plantain fingers (kg/ha)	diameter of plantain fruit finger (cm)	length of fruit finger (cm)	plantain finger population
Control	Nov 2007	2772.70a	2221.60a	2.2a	10.90a	9.0a
Wood ash	/Mar 2008	11529.45c	10555.25d	6.5b	20.30dc	28.00cd
NPK15-15-15		12496.5d	11215.65d	6.4b	17.80b	27.00c
Neem leaf		10833.30b	9580.65b	6.6bc	18.60bc	21.00b
modified neem- leaf		17777.5d	16495.45e	6.8d	19.3d	36.00c
Control	Nov 2008	2752.70a	2220.60a	2.8a	13.60a	10.00a
Wood ash	/Mar 2009	11941.10c	10833.33c	6.9bc	29.8c	27.00d
NPK15-15-15		12079.95d	10833.33c	5.8b	26.3b	26.00c
Neem leaf		9580.65b	8611.00b	6.3d	27.8c	23.00b
modified neem leaf		24165.95e	11944.10d	7.7d	28.3cd	29.00c

344 Treatment means within each column followed the same letters are not significantly

345 different from each other using Duncan Multiple Range Test at 5%

346

347

348

349

350

351 **TABLE 5: Soil Chemical Composition under Different Fertilizer Treatment after**
 352 **16 months of planting Plantain**

TREATMENTS	Soil pH	0.M %	N %	P mg/kg	K mmol/kg	Ca mmol/kg	Mg mmol/kg
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
Modified neem leaf extract	6.24d	1.68d	0.08c	8.10e	0.42e	1.29e	0.83de

353

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

356

357

358

359

360

361

362

363

364

365

366 REFERENCES

- 367 • **Adeoye, G.O (1986):** Comparative studies of Ammonium bi fluoride chelate
 368 extractants and some correctional extractant for sedimentary soils of S. W.
 369 Nigeria. PhD. Thesis, faculty of Agric & forestry, university of Ibadan, Nigeria.
- 370 • **Agboola A.A, 1982.** Soil testing, soil fertility and fertilizer use in Nigeria. A paper
 371 presented at the first National Seminar on Agricultural Land Resouces, Kaduna,
 372 Nigera pp 6-8.
- 373 • **Agboola, A.A and R.B. Corey, 1973.** Soil testing N, P, K for maize in the soils
 374 derived from metamorphic and igneous rocks of Western State of Nigeria. Nigeria
 375 Jour of West African Science 17(2): 93-100.
- 376 • **AOAC. 1970.** Official methods of Analysis 12th Edition. Association of Official
 377 Analytical Chemists, Arlington, VA.
- 378 • **Bouycous, H. 1951.** Mechanical analysis of soil using hydrometer method.
 379 Analytical Chem Acta. 22:32-34.
- 380 • **Crockford, L AND R. Nowell. 1956.** Laboratory manual of physical chemistry.
 381 Exp 31 and 32. John Wiley and Sons, New York.
- 382 • **Gomez, K.A AND A.A. Gomez. 1984.** Statistical procedure for Agricultural
 383 Research 2nd edition, John Wiley and sons. New York.
- 384 • **Ivbijaro, M.F. 1983.** Preservation of cowpea with neem seeds. Fuss Protec Eco
 385 1.5. 127 – 132.

- 386 • **Jackson, M. L. 1958.** Soil chemical analysis Englewood cliffs N.J. 1958 Prentice
387 Hall 59 – 67.
- 388 • **Jackson, M. L. 1958.** Soil chemical analysis Englewood cliffs N.J. 1958 Prentice
389 Hall 59 – 67.
- 390 • **Moyin-Jesu, E.I and Atoyosoye, B (2002)** Utilization of Agricultural Wastes for
391 the growth, leaf and soil chemical composition of cocoa seedling in the nursery.
392 Pertanika Jour of Tropical Agric Science 25(1):53-63.
- 393 • **Moyin-Jesu, E.I (2003).** Incorporation of Agro-Industrial Biomass and their
394 effects on growth and nutrient content of Amaranthus. Pertanika Jour of Trop.
395 Agric Science Malaysia 26(1): 49-58.
- 396 • **Moyin-Jesu, E.I (2007).** Evaluation of different organic fertilizers on the soil
397 fertility, leaf chemical composition and growth performance of coffee seedlings.
398 African Jour Sci. and Tech. (2):1-6
- 399 • **Moyin-Jesu, E. I. (2010):** Comparative evaluation of modified neem leaf, neem
400 leaf and wood ash extracts on soil fertility improvement, growth and yield of
401 maize and watermelon (sole and intercrop). Agricultural Sci. J Vol1 Jan 20121-8.
- 402 • **Moyin-Jesu, E. I. (2012):** Comparative evaluation of modified neem leaf, neem
403 leaf and wood ash extracts on soil fertility improvement, growth and yield of
404 maize and watermelon (sole and intercrop). Agricultural Sci. J Vol1 Jan 20121-8.
- 405 • **Murphy, J and J. P Riley 1962.** a modified single solution method

406 ○ for determination of phosphate in natural waters. Analytical Chem. Acta.
407 27, 31 – 36.

408 • **Ogunwale, J.A and Udo E.J 1978.** a laboratory manual for soil and plant
409 analysis. Agronomy Dept. University of Ibadan, Nigeria: 201 – 206.

410 • **Sobulo, R.A and Osiname, O.A. 1981.** Soils and fertilizer use in Western
411 Nigeria. Tech Bull, No 11, Institute of Agricultural Research and Training,
412 University of Ife, Nigeria pp 8 – 9.

413 • **Soil Survey Staff 1999.** Soil Taxonomy A basic system for soil classification for
414 making and interpreting soil surveys USDA Handbook No. 436, Washington, D.C,
415 USA.

416 • **Walkley, A and Black, I. A. 1934.** An examination of Degtjaroff method for
417 determining soil organic matter and a proposed modification of the chromic and
418 filtration soil Sci. 37: 29 – 38.

419 • **Wilson, G. F. 1986.** Status of banana and plantain in West Africa Proc Workshop
420 on Banana and Plantain breeding strategies. Cairns, Australia 13-17 Oct. Pp27-35.

421

422