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# Early Growth Response of *Irvingia gabonensis* Seedlings to Cowdung and NPK Fertilizer Application

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***Authors' contributions***

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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## ABSTRACT

Plants, unlike animals are naturally able to synthesize whatever compounds they need, require more than a dozen different elements [majorly Nitrogen, Phosphorus and Potassium (NPK)] as such. This study investigated the effect(s) of application of cow dung (CD) and NPK fertilizer on the early growth response of *Irvingia gabonensis.* Top soil samples of between 0 – 15 cm depth (control group I), top soil + NPK (Group II), top soil + cow dung (Group III) and top soil + NPK + cow dung (Group IV) were collected at varying combinations. The soils were then taken to the laboratory for physio-chemical analysis of key components [pH, N, P, $K^+$, $Ca^{2+}$, $Mg^{2+}$, $Na^+$, Org. C, sand, silt and clay]. Prior to and after actual experimentation, the N, P, K, Ca, Mg, Na, pH constituents of the cow dung were also analysed. For every two weeks (in twenty weeks duration) after application, plant heights, leaf area, number of leaf, stem girth were obtained and noted. By way of a sensitive weighing machine, 20 WAP destructive sampling was conducted to determine the weights of the shoot and root after oven-drying for three days in an oven sets at 75°C. In any case, these samples were then analysed for the nutrient content of the stem, root and leaf. Following data collection, comparisons of mean differences was performed using the Fishers protected least significant test

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and Duncan Multiple Range Test (DMRT) at 5% level of probability. Upon careful observation of result, study found that *Irvingia gabonensis* seedlings grown with cow-dung and NPK combination (Group IV) performed better in growth (height, diameter and leaf area) than seedlings grown in only top soil medium (TS) with single fertilizer use (Group II). However, NPK 3 CD 3, NPK 3 CD 2 and NPK 2 CD 3 best support the early growth phase of *Irvingia gabonensis* seedlings as compared to others. Study therefore showed Cow dung to contain substantial amount of essential elements that may be beneficial for the physio-chemical growth of *Irvingia wombolu* seedlings and combating reports of deforestations across the globe. It is recommended that for better results, cow-dung and NPK mixtures should be used than single use of the either treatments. Further studies aimed at corroborating this research are also recommended.

*Keywords: Cowdung; fertilizers; deforestation; Irvingia gabonensis.*

## 1. INTRODUCTION

Forests are the earth's reservoir of oxygen and they play an important role in the maintenance and enhancement of environmental quality. Africa is a continent with a forest cover of 21% [1], but owing to man`s pressure on land resources and exploitation of its flora, forests are currently faced with deleterious threats owing to numerous debilitating activities of man against the ecosystem [2,3].

Deforestation (cutting of trees, clearing and destruction of forests) as a major problem in world and Nigeria, which had in no small way led to a rapid decline in food and forest products supply. Many forest conservation initiatives have been launched, but to be sustainable, the management of forest must take into account the needs of the local people who depend on forest as a source of food, condiments, medicines and raw materials [2]. With a constant geometric increase in human population, while that of forest of forest product, benefit and food is rapidly declining and as such, there is a dire need to balance between human population increase and forest products by encouraging afforestation, reforestation and fertilization programmes. The rate at which the forest is being deforested in Nigeria was put at approximately 280,500 hectares annually, and by the year 2020 about 50% of our nation's forest would have been totally destroyed [4]. Domestication of indigenous fruit trees (*Irvingia* species) can help to tackle this problem [5,6].

*Irvingia gabonensis* belongs to the family Irvingiaceae. It is a semi-wild plant found mostly in the tropical region of Africa. Its geographical distribution ranges from Nigeria to Congo [7]. *Irvingia* species are among the most popular forest trees whose fruit pulp, seeds and leaves are utilized throughout West Africa and Central Africa for food and medicine. Considering this destruction, there is therefore a need to raise large plantation of indigenous tree species and this depend on good nursery techniques. Considering the use of manure to improve plant growth is important to obtain a vigorous and healthy growth of indigenous species attested to the need for urgent conservation of indigenous tree resources necessary for a successful plantation programme [8]. With an ever increasing expansion in construction activities, to improve urban and rural development, there had been an uncontrollable exploitation of our indigenous tree species that are of great importance to mankind. There is the need to replace the harvested valuable tree species and also to conserve valuable indigenous tree resources to meet the rising housing needs. Non timber products from forests and other tree system continue to be an important component of household, health and nutrition in Africa.

The Binis (inhabitants of southern Edo state, in the Niger Delta axis of Nigeria) have a distinct name for both *I. gabonensis* – "ogui". The common name for its specie (specific name) is Africa bush mango. The fruit of the species are eaten and the tree grows up to 25-30 metres high with 1.8m in grith, with a dense compact crown in West and Central Africa. The crown is umbrella shaped, the bowl is fluted and buttressed, flat topped or wide with horizontal, the leaves are elliptic to slightly obovate in shape [4]. The *I. gabonensis* fruits are relatively smaller in size, the seeds less slimy and less preferred for consumption than the *I. wombolu* [4,9].

*I. gabonensis* provides shade for food crops in farms and shelter in the villages for man. The period of harvest of the fruits of *I. gabonensis* is between February and March and the fruiting period (July to September). The fruits of *Irvingia gagbonensis* are similar in appearance to that of

cultivated mango (*Mangifera indica*) with variable colour from green to yellow when matured and rip [7]. The flowering and fruiting process consist of a series of sequential stages [6].

In spite of the numerous nutritional and medicinal benefits from *Irvingia* species, very little attention has been given to their domestication, with unimaginable higher than normal rates of its deforestation and mismanagement yearly. This poses a great danger that may lead to the extinction of this valuable forest species [1], which provide significant amount of firewood and non-woody forest (NWFP).

*Irvingia gabonensis* produces the most economically viable NTFP from the rain forest zone of West Africa [8]. It is found growing in the humid low land forests of tropical Africa in Angola, Cameroon, Central Africa Republic [5,6] and kernels are eaten in West Africa and central Africa [10]. Besides the effectiveness of the use of cow dung as a potting mixture component, the production of seedlings in large quantity will create an option for the disposal of cow dung from the abattoir. It could also create additional income for the farmer in the advent of high demand for the cow dung. Also it increases the activities of soil microbes with increase CEC of soil [10]. The organic manure required by plants includes; cow dungs, poultry dropping, plant and animal remains [11].

### 1.1 Aim of Study

This study aimed at determining the effect(s) of the application of cow dung and/or NPK fertilizer on the early growth responses of *Irvingia gabonensis* seedlings. Specifically, the study;

1. Determined the effects of cow dung and NPK fertilizer on the physio-chemical parameters [pH, N, P, $K^+$, $Ca^{2+}$, $Mg^{2+}$, $Na^+$, Org. C, sand, silt and clay] of *Irvingia gabonensis* seedlings;
2. Determined the effects of cow dung and NPK fertilizer on the early growth response of *Irvingia gabonensis* seedlings; and
3. Determined the suitable rate of application of both NPK and cow dung fertilizer for early growth response of *Irvingia gabonensis* seedlings.

## 2. METHODOLOGY

### 2.1 Study Area

The experiment was carried out in the department of Forestry and Wild Life Nursery, University of Benin, Benin City, Nigeria. The city has a minimum annual rainfall of about 1,500 mm with a temperature range of 27-31°C and a high relative humidity from 75% at mid-day of 95% at dawn (university of Benin Master Plan, 1993). The City lies between latitude 61°N and 68°N and between longitude 54°E and 60°E. The general topography can be regarded as low and the terrain is sloppy and gentle. The amount of annual rainfall is about 2,078 millimetres [12].

### 2.2 Scope of Study

This work takes account only of the extent to which *Irvingia* seedlings responds to different levels of fertilizers and cow dung in the nursery. This involves the response in terms of height of the seedlings (ruler), diameter (Thread and Ruler), leaf area, and leaf numbers, for a period of 20 weeks.

### 2.3 Study Design

The study adopted the factorial laid out in a complete randomized block design. The treatments were 4 levels each of cowdung and NPK (0, 30, 60 and 90 g) these were 16 treatments fertilizer combination and were replicated three times. Top soil samples (TS) of between 0 – 15 cm depth were collected and selected into various groups as; top soil only (control group I), top soil + NPK (Group II), top soil + cow dung (Group III) and top soil + NPK + cow dung (Group IV) at varying combinations (NPK 0 – 4) and (CD 0 – 4).

### 2.4 Procedures

**Seed and fertilizer acquisition:** Ripened fruit of *Irvingia gabonensis* was collected from Orowo Camp (Egba Town) in Uhunmwonde Local Government, Benin City. The seeds were extracted from the fruit manually by breaking the shell; the seed were tested for viability using floating method as prescribed by Opeke, (2005) [13]. The seeds were then pre-treated by soaking in water for 3 days to break the seed dormancy inherent in *Irvingia* seeds [14]. The NPK fertilizer was procured at Tony Best Agricultural Centre at Wire Road, Benin City and the Cowdung was obtained from cattle market along Benin technical college road Ugbowo, Benin City.

**Collection of soil samples:** Sixteen core samples were collected randomly from 0-15 cm depth on the forestry and wildlife department nursery using soil auger, mixed thoroughly and the bulked sample was taken to the laboratory,

air dried and sieved through 2 mm screen for chemical analysis

## 2.5 Laboratory Procedures

**Soils:** Soil Nitrogen determination was carried out using micokjeldahl procedure as described by Jackson, [15]. Percentage of Organic Carbon was determined by the Walkley-Black Wet Oxidation Method.

**Exchangeable bases:** Exchangeable Bases was determined by ammonium acetate extraction method while sodium and potassium were determined by flame photometry method, calcium and magnesium were determined by EDTA titration procedure [16]. Available Phosphorus was determined by Bray 1 method and the Phosphorus in the extract assayed calorimetrically by the molybdenum blue colour method of Murphy and Riley [17].

**Determination of pH:** About 20 g of fine soil weighed into a 100 ml beaker, 20 ml of distilled water added and stirred for 30 min. and pH taken using a table benchloride standardized pH method and results recorded as pH in water (1:1). Particle sizes of the soil were determined using hydrometer method [18], separating them into various separates of sand silt and clay in percentages.

**Analysis of plants tissue:** Nitrogen in plant was determined using Kjeldahl method same as reported for soils for other elements, P, Ca, Mg, Na were determined using an Auto Atomic Absorption Spectrophotometer [19].

**Cow Dung (CD):** Two grams each of the processed form was analysed. The percent N content was determined by Kjedahl method [15] while the determination of other nutrients such as P, K Ca, and Mg was done using the wet digestion method based on 25-5-5 ml of $HNO_3$-$H_2SO_4$-$HClO_4$ acids. The organic carbon was determined by wet oxidation method through chromic acid digestion.

## 2.6 Nursery Establishment of *Irvingia* sp.

The site was cleared to remove weeds and other debris and a shed was erected for the nursery. The bulk soil taken from the site (0-15 cm depth) was sieved to remove stones and plant debris and 2.0 kg of the sieved soil was weighed into a poly bag (30 x 17 cm). The treatments were incorporated into the soil using hand trowel and allowed to decompose for days before planting *Irvingia* seeds to the poly bags. Watering was done immediately and continued every morning and evening until the rain was steady. The first seed germination was observed 12 days after planting and complete germination of all planted seeds was observed 17 days from the planting date. Spraying of Karate (*Lamba cyhalotrin*) at 2ml active ingredient per 6litres of water against grass hoppers and army worms was done. Traps were also set at strategic points against rodent.

## 2.7 Data Collection

The Collection of data started two weeks after total germination and continued at two weeks intervals through to the end of the experiment Measurement was taken on the vegetative growth per plant per replicate and the average of each parameter taken. Destructive sampling was carried out at the end.

**Plant height in the experiment:** This represent the distance between the soil level in the polythene bag and the apex of each plant measured in cm.

i. **Number of leaf per plant:** It is recorded as real number. It is the average number of photosynthetic foliage leaf per plant.
ii. **Leaf area:** It is usually recorded as an approximation value by using this formula. Average length of the leaf x maximum breath across the leaf. Also, graphical method was used to evaluate this. A comparison of values from both methods was insignificant.
iii. **Stem girth:** This is the circumference of the stem at the base of the soil level. It is measured by the use of veneer calliper or the use of thread around the plant stem and measuring the length against a ruler in cm.

At the end of the experiment, seedling samples were collected from each treatments, oven dried for 3 days at 75 degree centigrade, and weighed. The chemical composition of leaf, root and stem was analysed for N, P, K, Ca, Mg and Na.

## 2.8 Analytical Approach

Data obtained were analysed statistically by a two way Analysis of variance (ANOVA). The treatment means were then separated where significant differences existed, using Duncan's Multiple Range Test (DMRT) and fishers protected least significant difference test at 5% level of probability [20,21].

## 3. RESULTS

Results are presented in the tables, following statistical analysis on obtained data.

## 4. DISCUSSION

It had become imperative to intensify research-based efforts at establishing and understanding the plantation of indigenous species of *Irvingia gabonensis* seedlings towards provision of seeds, nuts, fruits, leaves, roots and also mushrooms which are suitable for human consumption. Hitherto was this study designed.

From this study, a close look at Table 1 revealed that first seeds of *Irvingia gabonensis* emerged 12 days after planting with complete germination of all planted seeds observed 17 days from the planting date. There was however, less delay for the seeds of *Irvingia gabonensis.* Again, the soil chemical property before planting is represented in Table 1. Based on critical levels of soils in south and western Nigeria, the soil was slightly acidic (pH 5.88) and with 30 $gkg^{-1}$ organic carbon with the same critical level of 30 $gkg^{-1}$ which is considered optimal for most crops and fruit crops [22] while N (0.93 $gkg^{-1}$) is less than the critical level 1.50 $gkg^{-1}$ [23], while P (105.0 $gkg^{-1}$) is greater than the critical level (100 $gkg^{-1}$) [22]. The exchangeable K (0.250 $Cmolkg^{-1}$), Ca (0.85 $Cmolkg^{-1}$), Mg (0.60 $Cmolkg^{-1}$) were greater than the critical levels (0.20 $Cmolkg^{-1}$). The values obtained from the Table 1 after planting indicated an improvement on the soil generally by the treatments under study.

Again from Table 2, the application of NPK and cowdung at varying levels shows no significant differences ($P < 0.05$). However, results from NPK 1 CD 3 and NPK 3 CD 3 at all periods of observations outstandingly gave better performance. Notwithstanding, these and the other treatments did not give an appreciable result in comparison with the control. Particularly, at 4 WAP only NPK 1 CD 1, NPK 1 CD 3 and NPK 3 CD 3 shows better results, then NPK 2 CD 0, NPK 1 CD 1, NPK 1 CD 3 and NPK 3 CD 3 at 8 WAP, then NPK 2 CD 0, NPK 1 CD 3, NPK 3 CD 3, NPK 2 CD 2 at 12 WAP and then NPK 2 CD 0, NPK 1 CD 3 and NPK 3 CD 3, NPK 2 CD 2 and NPK 3 CD 1, 16 WAP. At 20 WAP there was a general drop in height suggesting another dose application of fertilizer at this point. This has a correlation with the work of Murphy (2002) that recorded better height performance of *Dalbergia sissoo* seedlings and so suggested that for better results, cow-dung mixture soil medium can be used [9].

The combined use of cow-dung and NPK is also gainful in view of the fact that the inorganic fertilizers are becoming too expensive to purchase by small scale farmers and intending seedling producers of bush mango. Besides, this organic fertilizer appears to have a strong beneficial secondary effect on the soil properties and environmental friendly. These observations also agrees with Adebayo and Akoun, (2010) who reported that organic manures supported crop growth performance and increase crop yield [24]. Babalola et al. [24] as well reported that poultry manure when used as fertilizer stimulates microbial activities thereby enhancing the release of organic N and P in the soil [25]. Notwithstanding the observed drop in numbers of leaf which might have resulted from leaf shedding as influenced by water stress in the semi-dry season. Similar results were also found by Kozlowski [25] in growth study of different *Albizia* species in different seasons of the year [25].

Also, there was significant difference ($p < 0.05$) of the stem girth measurement of the seedlings among the fertilizer applications. The seedlings that were grown on NPK 3 CD 3 had the largest overall mean stem girth (2.044 mm). The least was from the control (1.704 mm). At 4 WAP, NPK 1 CD 3 and NPK 3 CD 3 recorded the highest girth measurement while at 8, 12 and $16^{th}$ WAP, shows an appreciable results. However, results at each points were close and shows a plateau with a sharp increase in 8 WAP and maintained through 12 WAP and 16WAP and then declined sharply again at 20 WAP indicating requirement of another dose of fertilization.

Again, the mean leaf number of *I. gabonensis* seedlings differed significantly ($P < 0.05$) among the fertilizer treatment levels and combinations. the overall mean leaf number of seedling grown on NPK 0 CD 2 was the highest with a mean value of 20.27 which was not significantly different from the mean obtained from NPK 1 CD 3 (19.07) and NPK 3 CD 1 (17.20). These were the only outstanding results in comparison with the mean value obtained from the control (14.67) which was even better than the other treatments with the least value obtained from seedlings on NPK 3 CD 0 (9.07). The results performance at the 20 WAP declined generally also indicating a used up of available nutrient and therefore requiring another dose to support

**Table 1. Soil and cowdung chemical composition before and after planting**

| | pH | N $gkg^{-1}$ | AV.P $gkg^{-1}$ | K $Cmolkg^{-1}$ | Na $Cmolkg^{-1}$ | Ca $Cmolkg^{-1}$ | Mg $Cmolkg^{-1}$ | Org.C $gkg^{-1}$ | SAND $gkg^{-1}$ | SILT $gkg^{-1}$ | CLAY $gkg^{-1}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| B.P | 5.88 | 0.93 | 105.0 | 0.25 | 0.10 | 0.85 | 0.60 | 30.0 | 850 | 40.0 | 110.0 |
| A.P | 6.101 | 2.11 | 105.6 | 0.244 | 0.057 | 1.5 | 0.29 | 24.9 | 862 | 36.1 | 102.1 |
| CD | 7.06 | 5.20 | 30.1 | 0.20 | 0.10 | 1.12 | 0.43 | 55.1 | - | - | - |

*BP – Before Planting, AP – After Planting, CD – Cowdung. The first seeds of Irvingia spp emerged 12 days after planting and complete germination of all planted seeds was observed 17 days from the planting date. There was however, a delay for the seeds of Irvingia gabonensis*

further production. This might also be the fact that leaf shedding was influenced by water stress in the semi-dry season.

There was a sharp drop at the 20th week in most of the chemical uptake as shown in the Tables 3 and 4 could indicate an exhaustion of the nutrients provided by the fertilization. The seedlings at this point obviously were set for transplanting and if a longer stay were necessary a need for another dose would thus be required.

The mean leaf area of *I. gabonensis* seedlings differed significantly among the fertilizer treatment levels and combinations. The seedlings that were grown on NPK 1 CD 3 had the largest mean leaf area (99.38 $cm^2$) and were significantly different from the values obtained from seedlings grown on the other treatments. The least value was obtained from NPK 1 CD 0 (68.23) which were not significantly different from NPK 2 CD 1 (70.58), the control (72.05), NPK 0 CD 2 (73.54), NPK 1 CD 1 (75.71), NPK 2 CD 0 (75.84), NPK 2 CD 3 (77.53) and NPK 2 CD 2

**Table 2. Effects of NPK and Cowdung on vegetative growth of *Irvingia gabonensis* seedlings**

| Treatment | Plant height | Stem girth | Number of leaf | Leaf area |
|---|---|---|---|---|
| NPK0_CD0 | 37.82 | 1.7042$^{e}$ | 14.67$^{bcd}$ | 72.05$^{efg}$ |
| NPK0_CD1 | 35.38 | 1.7074$^{e}$ | 11.80d$^{ef}$ | 80.40$^{bcdef}$ |
| NPK0_CD2 | 33.52 | 1.7106$^{e}$ | 20.27$^{a}$ | 73.54$^{defg}$ |
| NPK0_CD3 | 30.28 | 1.8034$^{cde}$ | 9.47$^{f}$ | 79.70$^{bcdef}$ |
| NPK1_CD0 | 30.64 | 1.7652$^{cde}$ | 11.20d$^{ef}$ | 68.23$^{g}$ |
| NPK1_CD1 | 38.34 | 1.7784$^{cde}$ | 9.67$^{ef}$ | 75.70$^{cdefg}$ |
| NPK1_CD2 | 29.46 | 1.7212$^{de}$ | 9.40$^{f}$ | 87.12$^{b}$ |
| NPK1_CD3 | 51.04 | 1.9766$^{ab}$ | 19.07$^{ab}$ | 99.38$^{a}$ |
| NPK2_CD0 | 37.46 | 1.9706$^{ab}$ | 12.87$^{cdef}$ | 75.84$^{cdefg}$ |
| NKP2_CD1 | 34.86 | 1.8794$^{bcd}$ | 9.40$^{f}$ | 70.58$^{fg}$ |
| NPK2_CD2 | 34.30 | 1.9208$^{abc}$ | 11.27$^{def}$ | 78.55$^{bcdefg}$ |
| NPK2_CD3 | 35.46 | 1.8792$^{bcd}$ | 11.20$^{def}$ | 77.53$^{bcdefg}$ |
| NPK3_CD0 | 29.32 | 1.7868$^{cde}$ | 9.07$^{f}$ | 82.43$^{bcd}$ |
| NPK3_CD1 | 36.68 | 2.0378$^{ab}$ | 17.20$^{abc}$ | 78.76$^{bcdef}$ |
| NPK3_CD2 | 34.70 | 1.7862$^{cde}$ | 14.34$^{bcde}$ | 84.47$^{bc}$ |
| NPK3_CD3 | 50.42 | 2.0438$^{a}$ | 12.94$^{cdef}$ | 81.73$^{bcde}$ |

**Means followed by the same superscript are not significantly different at 5 % level of probability*

**Table 3. Root mineral uptake with NPK and Cowdung fertilization of *Irvingia gabonenesis* seedlings**

| Treatment | Nitrogen | Phosphorus | Potassium | Calcium | Magnesium |
|---|---|---|---|---|---|
| NPK0_CD0 | 0.0255$^{cd}$ | 0.0025 | 0.0231$^{b}$ | 0.0035$^{a}$ | 0.0030$^{a}$ |
| NPK0_CD1 | 0.0280$^{bcd}$ | 0.0029 | 0.0126$^{fg}$ | 0.0033$^{ab}$ | 0.0020$^{b}$ |
| NPK0_CD2 | 0.0343$^{abc}$ | 0.0034 | 0.0171$^{de}$ | 0.0023$^{cde}$ | 0.0010$^{c}$ |
| NPK0_CD3 | 0.0382$^{a}$ | 0.0035 | 0.0153$^{defg}$ | 0.0032$^{ab}$ | 0.0028$^{a}$ |
| NPK1_CD0 | 0.0357$^{ab}$ | 0.0029 | 0.0143$^{efg}$ | 0.0033$^{ab}$ | 0.0011$^{c}$ |
| NPK1_CD1 | 0.0286$^{bcd}$ | 0.0026 | 0.0192$^{cd}$ | 0.0019$^{de}$ | 0.0029$^{a}$ |
| NPK1_CD2 | 0.0209$^{d}$ | 0.0029 | 0.0145$^{efg}$ | 0.0029$^{abc}$ | 0.0030$^{a}$ |
| NPK1_CD3 | 0.0261$^{cd}$ | 0.0032 | 0.0224$^{bc}$ | 0.0021$^{de}$ | 0.0010$^{c}$ |
| NPK2_CD0 | 0.0369$^{ab}$ | 0.0031 | 0.0269$^{a}$ | 0.0025$^{cd}$ | 0.0017$^{b}$ |
| NKP2_CD1 | 0.0249$^{cd}$ | 0.0027 | 0.0123$^{fg}$ | 0.0034$^{ab}$ | 0.0353 |
| NPK2_CD2 | 0.0260$^{cd}$ | 0.0027 | 0.0163$^{def}$ | 0.0027$^{bc}$ | 0.0213 |
| NPK2_CD3 | 0.0301$^{abcd}$ | 0.0026 | 0.0175$^{de}$ | 0.0017$^{e}$ | 0.0367 |
| NPK3_CD0 | 0.0214$^{d}$ | 0.0028 | 0.0119$^{g}$ | 0.0018$^{de}$ | 0.0237 |
| NPK3_CD1 | 0.0233$^{d}$ | 0.0029 | 0.0171$^{de}$ | 0.0019$^{de}$ | 0.0223 |
| NPK3_CD2 | 0.0207$^{d}$ | 0.0033 | 0.0160$^{defg}$ | 0.0029$^{abc}$ | 0.0173 |
| NPK3_CD3 | 0.0224$^{d}$ | 0.0029 | 0.0178$^{de}$ | 0.0021$^{de}$ | 0.0210 |

**Means followed by the same superscript are not significantly different at 5 % level of probability*

**Table 4. Stem mineral uptake with NPK and Cowdung fertilization of *Irvingia gabonenesis* seedlings**

| Treatment | Nitrogen | Phosphorus | Potassium | Calcium | Magnesium |
|---|---|---|---|---|---|
| NPK0_CD0 | 0.0958$^{de}$ | 0.0389$^{b}$ | 0.1735$^{gh}$ | 0.00407$^{f}$ | 0.00407$^{f}$ |
| NPK0_CD1 | 0.0851$^{e}$ | 0.0485$^{a}$ | 0.1802$^{gh}$ | 0.00543$^{b}$ | 0.00543$^{b}$ |
| NPK0_CD2 | 0.1035$^{de}$ | 0.0398$^{b}$ | 0.2047$^{fg}$ | 0.00465$^{d}$ | 0.00465$^{d}$ |
| NPK0_CD3 | 0.1338$^{de}$ | 0.0481$^{a}$ | 0.1609$^{hi}$ | 0.00547$^{b}$ | 0.00547$^{b}$ |
| NPK1_CD0 | 0.1376$^{de}$ | 0.0338$^{bc}$ | 0.1935$^{gh}$ | 0.00512$^{bc}$ | 0.00512$^{bc}$ |
| NPK1_CD1 | 0.1473$^{de}$ | 0.0384$^{b}$ | 0.1649$^{hi}$ | 0.00425$^{f}$ | 0.00425$^{f}$ |
| NPK1_CD2 | 0.1440$^{de}$ | 0.0391$^{b}$ | 0.1575$^{hi}$ | 0.00419$^{f}$ | 0.00419$^{f}$ |
| NPK1_CD3 | 0.2307$^{c}$ | 0.0298$^{cd}$ | 0.2383$^{ef}$ | 0.00415$^{f}$ | 0.00415$^{f}$ |
| NPK2_CD0 | 0.2627$^{bc}$ | 0.0343$^{bc}$ | 0.2460$^{e}$ | 0.00423$^{f}$ | 0.00423$^{f}$ |
| NKP2_CD1 | 0.2673$^{bc}$ | 0.0205$^{fg}$ | 0.2374$^{ef}$ | 0.00389$^{f}$ | 0.00389$^{f}$ |
| NPK2_CD2 | 0.3773$^{a}$ | 0.0382$^{b}$ | 0.3623$^{c}$ | 0.00486$^{cd}$ | 0.00486$^{cd}$ |
| NPK2_CD3 | 0.3020$^{b}$ | 0.0157$^{g}$ | 0.3480$^{cd}$ | 0.00407$^{f}$ | 0.00407$^{f}$ |
| NPK3_CD0 | 0.2987$^{c}$ | 0.0161$^{g}$ | 0.5259$^{a}$ | 0.00488$^{cd}$ | 0.00488$^{cd}$ |
| NPK3_CD1 | 0.2807$^{bc}$ | 0.0233$^{ef}$ | 0.3203$^{d}$ | 0.00538$^{b}$ | 0.00538$^{b}$ |
| NPK3_CD2 | 0.1570$^{d}$ | 0.0279$^{de}$ | 0.4239$^{b}$ | 0.00459$^{d}$ | 0.00459$^{d}$ |
| NPK3_CD3 | 0.1378$^{de}$ | 0.0219$^{f}$ | 0.1338$^{i}$ | 0.00591$^{a}$ | 0.00591$^{a}$ |

**Means followed by the same superscript are not significantly different at 5 % level of probability*

**Table 5. Leaf mineral uptake with NPK and Cowdung fertilization of *Irvingia gabonenesis* seedlings**

| Treatment | Nitrogen | Phosphorus | Potassium | Calcium | Magnesium |
|---|---|---|---|---|---|
| NPK0_CD0 | 0.1760$^{b}$ | 0.0340$^{a}$ | 0.2507$^{c}$ | 0.0057$^{d}$ | 0.0032$^{efg}$ |
| NPK0_CD1 | 0.0521$^{g}$ | 0.0189$^{ef}$ | 0.1205$^{f}$ | 0.0056$^{d}$ | 0.0032$^{ef}$ |
| NPK0_CD2 | 0.0529$^{g}$ | 0.0183$^{f}$ | 0.1210$^{f}$ | 0.0045$^{g}$ | 0.0027$^{ij}$ |
| NPK0_CD3 | 0.0520$^{g}$ | 0.0193$^{def}$ | 0.1210$^{f}$ | 0.0043$^{gh}$ | 0.0030$^{gh}$ |
| NPK1_CD0 | 0.0568$^{g}$ | 0.0200$^{cdef}$ | 0.1205$^{f}$ | 0.0042$^{hi}$ | 0.0030$^{gh}$ |
| NPK1_CD1 | 0.0605$^{g}$ | 0.0211$^{bcde}$ | 0.1211$^{f}$ | 0.0037$^{j}$ | 0.0027$^{ij}$ |
| NPK1_CD2 | 0.0600$^{g}$ | 0.0209$^{bcde}$ | 0.1225$^{f}$ | 0.0038$^{j}$ | 0.0029$^{hi}$ |
| NPK1_CD3 | 0.0603$^{g}$ | 0.0205$^{bcdef}$ | 0.1225$^{f}$ | 0.0040$^{i}$ | 0.0031$^{fgh}$ |
| NPK2_CD0 | 0.0602$^{g}$ | 0.0221$^{bc}$ | 0.1263$^{f}$ | 0.0043$^{gh}$ | 0.0026$^{j}$ |
| NKP2_CD1 | 0.0776$^{f}$ | 0.0225$^{b}$ | 0.1673$^{e}$ | 0.0048$^{f}$ | 0.0034$^{e}$ |
| NPK2_CD2 | 0.0967$^{e}$ | 0.0204$^{bcdef}$ | 0.2027$^{d}$ | 0.0062$^{c}$ | 0.0046$^{d}$ |
| NPK2_CD3 | 0.1059$^{de}$ | 0.0190$^{ef}$ | 0.2082$^{d}$ | 0.0076$^{a}$ | 0.0050$^{c}$ |
| NPK3_CD0 | 0.1105$^{de}$ | 0.0211$^{bcde}$ | 0.3118$^{b}$ | 0.0078$^{a}$ | 0.0060$^{a}$ |
| NPK3_CD1 | 0.1153$^{c}$ | 0.0214$^{bcd}$ | 0.4000$^{a}$ | 0.0079$^{b}$ | 0.0053$^{b}$ |
| NPK3_CD2 | 0.1227$^{c}$ | 0.0200$^{cdef}$ | 0.4000$^{a}$ | 0.0053$^{e}$ | 0.0032$^{ef}$ |
| NPK3_CD3 | 0.2290$^{a}$ | 0.0360$^{a}$ | 0.4000$^{a}$ | 0.0047$^{f}$ | 0.0026$^{j}$ |

**Means followed by the same superscript are not significantly different at 5% level of probability*

(78.55) (Table 5). The leaf area at 4 WAP gave almost uniform values with all treatments. Variations emerged from the 8 WAP and consistently followed through to 16 WAP and declined sharply generally at 20 WAP. NPK 1 CD 0 recorded the significantly least value. NPK 1 CD 3 and NPK 1 CD 2 had much better results particularly at 8 WAP, 12 WAP and 16 WAP.

## 5. CONCLUSION

Within the ambient of vulnerability to possible human and/or analytical errors, current study has shown that Cow dung contains substantial amount of essential elements, especially Nitrogen, Organic Carbon, Phosphorus, Calcium and Magnesium. That may be beneficial for the physio-chemical growth and improvements of *Irvingia wombolu* seedlings in the bid to combat the seemingly rising surge in modern deforestations across the globe. Study also has shown a significant difference in vegetative growth and height in *Irvingia gabonensis* seedlings, revealing a nutrient content uptake (N, P, K, Ca and Mg) of the root, leaf and stem were significantly different for the different

combinations of NPK and cow dung fertilizer application to *Irvingia wombolu* seedlings.

## 6. RECOMMENDATIONS

1. It is recommended that for better results, cow-dung and NPK mixture should be used than single use of the either treatments.
2. It is also recommended that periods beyond 20 weeks should require another dose of these fertilizer combinations

## ETHICAL APPROVAL

Ethical clearance was obtained from the Research and Ethics Committee of the Faculty of Agriculture, University of Benin, Benin City, Edo State.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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