Physio-Chemical Alterations and Early Growth Response in Application of Cow dung and NPK Fertilizer to *Irvingia* wombolu Seedlings

Abstract:

This study examined the changes in selected physical [Sand, Silt and Clay] and chemical [pH, N, P, K^+, Ca^{2+}, Mg^{2+}, Na^+, Org. C] compositions of different soil samples, and their possible effect(s) on the early growth and response of *Irvingia wombolu* seedling, following application of cow dung (CD) and NPK fertilizer. Top soil samples (TS) of between 0 – 15cm depth were collected and applied on *Irvingia wombolu* at varying combinations (NPK 0 – 4) and (CD 0 – 4) as follows; 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). The soils were then taken to the laboratory and assayed for physio-chemical changes in major components as; 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 on a total of 20 weeks period, thereafter, plant heights, leaf area, leaf number and stem girth were obtained and recorded. Using a sensitive weighing balance, 20 WAP destructive sampling was performed to ascertain the root and shoots weights after oven-drying for three days at about 75^oC. Obtained samples were then analysed for the nutrient content of stem, root, and leaf. After data collection, comparisons of differences between means was conducted using the Fishers protected least significant test and Duncan Multiple Range Test (DMRT) with p-value set at 0.05 level of confidence. Careful observation of results revealed that *Irvingia wombolu* seedlings than those 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 wombolu* seedlings as compared to others. It is recommended that periods beyond 20 weeks should require another dose of these fertilizer combinations. Further studies aimed at corroborating this research are also recommended.

Keywords: *Irvingia wombolu*, Cow dung, Fertilizer, NPK

Introduction

For germination to occur, certain conditions must be fulfilled namely; the seeds must be viable; the internal condition must be favourable. Environmental condition such as appropriate temperature, oxygen, water and light situation must be adequate. The leaves of young *Irvinga species* are usually pale green, from field and nursery observation even as matured trees [1].

The seed in the fruit lose viability within 4 weeks of falling [2]. It cannot be conserved in ex situ seed banks [3, 4]. The seed coat of both varieties is thick and hard and physical dormancy is a general phenomenon for all hard seeded species [5]. Due to hard seed

coat of the species, various methods have been employed, to hasten the germination. These are by exposing the seeds to ultra violet rays as reported by Nwoboshi (1982) and by rubbing the seed against rough wall, sand paper to help break dormancy inherent in irvingia seeds [6]. These methods have been very effective in promoting early growth and uniform germination as well as better seedlings growth. The seedling at the nursery stage should be placed on shade [7].

Irvingia wombolu (Aubry-Lecomte ex O'Rorke Baill) belong to the family irvingiaceae with the class Angiospermae and sub-class dicotyledonae. Its local names include Uyo (Efik) and Ogbono (Ibo). It grows up to 25-30 meters in height and 1.8 meters in girth; with a dense compact crown. The bole is often fluted and buttressed the bark is smooth or slightly scaly and grayish in colour. The leaves are 15cm long, 2.5 to 6.5cm broad and are elliptic and shiny green in colour. There are two distinct species, namely. According to Okeke (1995), the kernels of *Irvingia wombolu* has a great drawability and thickening attributes [7]. However, this takes place because of the chemical change during ripening which usually involves the conversion of starch to sucrose and reducing sugar. The extent of this conversion affects the sweetness of ripe and matured fruit [8].

Most farmers in the Central and West Africa maintains mature bush mango trees that are already grown on their land, which will help to transplant seedlings into their farms which has helped in transplanting seedlings into their farm [9]. Also, new seedlings are also raised from good quality seeds from trees [10].

Despite the efficacy of organic manure such as the use of cow dung, there are problems associated with the cow dung such as irritating smell. This unpleasant smell discourages most farmers and foresters from using cow dung as organic fertilizers for raising tree seedlings and other agriculture crops. The seed cotyledon of the *Irvingia* is highly valued for its food thickening property and commercial value. There exist local and regional markets for Non Timber Forest Products (NTFPs) of Irvingia species [4].

Irvingia fruits have both nutritive value to man and economic benefits to the nation. The kernels are also made into a cake called 'dika bread' or 'odika bread' for year-round preservation and easy use. Edible oil is extracted from the seed and used in cooking. The press cake is a good cattle feed and is suitable in the food industry. The pulp of the fruit of *Irvingia wombolu* is bitter and slimy and is occasionally added to soups as thickener. *I. wombolu* and *I. gabonensis* are commonly preserved when clearing land for agriculture to provide shade for, cocoa, coffee also annual crops. Preparations from the bark are rubbed on

to the body to relieve pains and are applied to sores and wounds and against toothache. They are also used for the treatment of diarrhoea. The Igbo people use a leaf extract as a febrifuge. Organic manure is the decomposed waste from living organisms such as faeces, plant and animal litter, cow dung, poultry manure, farmyard manure and green manure. The mineralization of manure is governed by the biological, chemical and physical properties of soil and is a function of the organic manure, soil moisture and soil temperature [10].

The use of manure may be suitable for obtaining good and healthy growth and development of the seedlings [11]. Soils that are warm, moist and well aerated have the highest potential rate of organic manure mineralization. Lower potential rate should be expected when soils are dry, cold, or saturated with water. The inorganic materials that are released during this process are the essential plant nutrient (N. P. K). The factors that govern the amount of organic manure and inorganic manure fertilizers to be applied to soil is dependent on the soil pH level, types of crops to be grown, soil type, fertility status, and the moisture content of the soil. However, inorganic fertilizer contains a very high amount of nutrient compared to organic fertilizer. It is also easy to handle, transport, apply and not too bulky. Incorporation of organic manure into the Soil improves the structure of the Soil, encourage infiltration of water thereby preventing erosion. It increases the cohesion of sand, supply humus to the Soil and also promotes soil aeration. Animal manure favoured by the activities of microorganism which aid the process of its decomposition, such that the nutrients are tied up, are released and thus made available for the plant use.

Aim of Study

Current study examined the effect(s) of the changes in selected physio-chemical parameters, on the early growth responses of *Irvingia wombolu* seedlings following application of cow dung and/or NPK fertilizer over a period of time. Specifically, the study;

1. Determined the effects of cow dung and NPK fertilizer on the physical parameters [sand, silt and clay] of *Irvingia wombolu*;
2. Determined the effects of cow dung and NPK fertilizer on selected chemical parameters [pH, N, P, K^+, Ca^{2+}, Mg^{2+}, Na^+, Org. C] of *Irvingia wombolu*;
3. Investigated the effects of cow dung and NPK fertilizer on the early growth response of *Irvingia wombolu* seedlings; and

Methodology

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 1,500mm with a temperature range of 27-31^{0}C and a high relative humidity from 75% at mid-day of 95% at dawn [12]. The City lies between latitude 61^{0}N and 68^{0}N and between longitude 54^{0}E and 60^{0}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].

Scope of Study

This work takes account only of the extent to which *Irvingia wombolu* 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.

Study Design

The study adopted the factorial laid out in a complete randomized block design. The treatments were 4 levels each of cow dung 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 – 15cm 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).

Procedures

Seed and Fertilizer Acquisition

Ripened fruit of *Irvingia wombolu* 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 (1997) [11]. 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 Cow dung was obtained from cattle market along Benin technical college road Ugbowo, Benin City.

Collection of Soil Samples

Sixteen core samples were collected randomly from 0-15cm 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 2mm screen for chemical analysis

Laboratory Procedures

Soils

Soil Nitrogen determination was carried out using micokjeldahl procedure as described by Jackson, 1962 [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 (1962) [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 25-5-5ml of HNO_3-H_2SO_4-$HClO_4$ acids. The organic carbon was determined by wet oxidation method through chromic acid digestion.

Nursery Establishment of *Irvingia* spp

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 (0-15cm 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.

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.

Ethical Clearance

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

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].

Results

Table I: Soil and Cow dung 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.*

Table II: Effects of NPK and Cow dung on Vegetative Growth of *Irvingia wombolu* seedlings

TRT	Plant Height	Stem Girth	Number of Leaf	Leaf Area
NPK0_CD0	32.032^{bcd}	1.3530	13.53^{abcd}	74.74^{bcd}
NPK0_CD1	30.554^{bcd}	1.4260	9.07^{ab}	74.82^{bcd}
NPK0_CD2	26.812^{abc}	1.1500	12.20^{bcd}	70.86^{bcd}
NPK0_CD3	27.130^{d}	1.5500	9.67^{bcd}	66.72^{de}
NPK1_CD0	30.832^{bcd}	1.4230	10.87^{bcd}	55.82^{e}
NPK1_CD1	28.846^{cd}	1.3650	11.13^{bcd}	73.78^{bcd}
NPK1_CD2	30.606^{bcd}	1.3600	8.87^{d}	71.96^{bcd}
NPK1_CD3	35.446^{abcd}	1.1140	14.27^{ab}	78.84^{bc}
NPK2_CD0	29.092^{cd}	1.5580	11.87^{bcd}	73.66^{bcd}
NKP2_CD1	32.620^{abcd}	1.3620	11.80^{bcd}	74.48^{bcd}
NPK2_CD2	33.528^{abcd}	1.6190	9.67^{bcd}	75.26^{bcd}
NPK2_CD3	38.460^{ab}	1.4150	14.13^{abc}	92.36^{a}
NPK3_CD0	30.418^{bcd}	1.3120	18.00^{a}	79.58^{b}
NPK3_CD1	28.698^{cd}	1.3210	11.33^{bcd}	76.12^{bcd}
NPK3_CD2	27.080^{d}	1.6260	8.53^{d}	79.96^{b}
NPK3_CD3	40.662^{a}	1.4380	10.20^{bcd}	67.28^{cde}

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

Table III: Root Mineral uptake with NPK and Cow dung fertilization of *Irvingia wombolu* seedlings

TRT	Nitrogen	Phosphorus	Potassium	Calcium	Magnesium
NPK0_CD0	0.020^{h}	0.0023^{h}	0.15000^{b}	0.0250^{a}	0.0030^{a}
NPK0_CD1	0.021^{g}	0.0021^{k}	0.05400^{j}	0.0160^{c}	0.0022^{c}
NPK0_CD2	0.040^{d}	0.0030^{g}	0.08500^{d}	0.0150^{d}	0.0010^{d}
NPK0_CD3	0.044^{c}	0.0040^{e}	0.06500^{h}	0.0200^{b}	0.0019^{b}
NPK1_CD0	0.046^{b}	0.0051^{c}	0.07000^{g}	0.0150^{d}	0.0010^{d}
NPK1_CD1	0.020^{h}	0.0031^{f}	0.07500^{f}	0.0100^{e}	0.0020^{e}
NPK1_CD2	0.011^{k}	0.0021^{j}	0.05500^{i}	0.0200^{b}	0.0030^{b}
NPK1_CD3	0.040^{d}	0.0030^{g}	0.15000^{b}	0.0050^{f}	0.0030^{f}
NPK2_CD0	0.047^{a}	0.0050^{d}	0.15500^{a}	0.0100^{e}	0.0019^{e}
NKP2_CD1	0.013^{i}	0.0020^{L}	0.05000^{k}	0.0250^{a}	0.0010^{a}
NPK2_CD2	0.039^{e}	0.0030^{g}	0.09000^{c}	0.0200^{b}	0.0020^{b}
NPK2_CD3	0.031^{f}	0.0021^{j}	0.08000^{e}	0.0200^{b}	0.0020^{b}
NPK3_CD0	0.011^{k}	0.0011^{m}	0.05000^{k}	0.0050^{f}	0.0019^{f}
NPK3_CD1	0.011^{w}	0.0022^{i}	0.07533^{f}	0.0053^{f}	0.0019^{f}
NPK3_CD2	0.020^{h}	0.0211^{b}	0.08000^{e}	0.0050^{f}	0.0010^{f}
NPK3_CD3	0.012^{p}	0.0220^{a}	0.09000^{c}	0.0100^{e}	0.0020^{e}

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

Table IV: Stem Mineral uptake with NPK and Cow dung fertilization of *Irvingia wombolu* seedlings

TRT	Nitrogen	Phosphorus	Potassium	Calcium	Magnesium
NPK0_CD0	0.0500^{m}	0.0200^{g}	0.120^{L}	0.0310^{e}	0.0036^{f}
NPK0_CD1	0.0530^{j}	0.0180^{i}	0.122^{k}	0.0255^{g}	0.0026^{m}
NPK0_CD2	0.0510^{L}	0.0190^{h}	0.122^{k}	0.0205^{k}	0.0034^{i}
NPK0_CD3	0.0520^{k}	0.0210^{f}	0.123^{j}	0.0210^{j}	0.0027^{L}
NPK1_CD0	0.0600^{i}	0.0200^{g}	0.123^{j}	0.0195^{m}	0.0026^{m}
NPK1_CD1	0.0610^{h}	0.0220^{d}	0.124^{i}	0.0185^{n}	0.0029^{k}
NPK1_CD2	0.0610^{h}	0.0200^{g}	0.122^{k}	0.0200^{L}	0.0030^{j}
NPK1_CD3	0.0600^{i}	0.0220^{d}	0.130^{h}	0.0200^{L}	0.0035^{h}
NPK2_CD0	0.0600i	0.0240^{c}	0.210^{f}	0.0225^{i}	0.0027^{L}
NKP2_CD1	0.0625^{g}	0.0215^{e}	0.206^{g}	0.0252^{h}	0.0050^{b}
NPK2_CD2	0.0910^{f}	0.0210^{f}	0.214^{e}	0.0355^{c}	0.0048^{c}
NPK2_CD3	0.1000^{e}	0.0190^{h}	0.410^{b}	0.0405^{a}	0.0067^{a}
NPK3_CD0	0.1110^{c}	0.0230^{d}	0.410^{b}	0.0385^{b}	0.0045^{d}
NPK3_CD1	0.1100^{d}	0.0240^{c}	0.400^{d}	0.0320^{d}	0.0035^{h}
NPK3_CD2	0.1210^{b}	0.0250^{b}	0.411^{a}	0.0225^{i}	0.0040^{e}
NPK3_CD3	0.1258^{a}	0.0532^{a}	0.402^{c}	0.0261^{f}	0.0036^{g}

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

Discussion

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, and could also create additional income for the farmer in the advent of high demand for the cow dung; also increasing the activities of soil microbes with increase CEC of soil. The organic manure required by plants includes; cow dungs, poultry dropping, plant and animal remains [10]. The inorganic fertilizers are becoming too expensive to buy and very scarce, besides, cow dung appears to have a strong beneficial effect on the soil properties, and could be environmental friendly. Also, Obi and Ofondiru (1997) reported that the continuous use of mineral fertilizer (NPK, Urea) had led to soil degradation physical qualities, and low soil organic matter and effects on water bodies. Organic fertilizer will obviously create a placating effect on these conditions listed above. This study investigated the extent to which *Irvingia wombolu* seedlings responds to different levels of fertilizers and cow dung in the nursery. The study detailed 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.

From the findings of this study, based on critical levels of soils in south and western Nigeria (table I), 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 [21] while N (0.93 gkg^{-1}) is less than the critical level 1.50 gkg^{-1}, while P (105.0 gkg^{-1}) is greater than the critical level (100 gkg^{-1}) [21]. 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 table I above after planting indicated an improvement on the soil generally by the treatments under study.

Nitrogen nutrient uptake through the roots had similar trend at all the periods of the experiment. Generally, it was observed that uptake was highest in NPK 2 CD 0, closely followed by NPK 1 CD 0 and NPK0 CD 3 which were insignificantly different from the other. NPK 0 CD 2, NPK 1 CD 3 and NPK 2 CD 2 had similar uptake values. The least was obtained with NPK 3 CD 1, NPK 3 CD 0, NPK 1 CD 2, NPK 1 CD 2, NPK 3 CD 3 and NPK 2 CD 1 in such increasing order (table II). The control (NPK 0 CD 0) uptake values was not significantly different from values obtained with NPK 3 CD 2, NPK 1 CD 1 and NPK 1 CD 3.

Phosphorus uptake in the analyzed roots of *I. wombolu* seedling was outstandingly highest from in NPK 3 CD 3 and NPK 3 CD 2 and the least value obtained from NPK 3 CD 0. NPK 0 CD 2, NPK 1 CD 3 and NPK 2 CD 2 were insignificantly different ($p < 0.05$) (table III). Also, NPK 1 CD and NPK 2 CD 3 were also not significantly different ($p < 0.05$). The potassium uptake in the roots shows no significance ($P < 0.05$) with NKP 2 CD 1 and NPK 3 CD 0. Also NPK 1 CD 1 and NPK 3 CD 1 were not significantly different at 5% probability level. This was also the case for NPK 2 CD 3 and NPK 3 CD 2 as well as NPK 2 CD 2 and NPK 3 CD 3. NPK 2 CD 0 gave the highest value and followed by the control (NPK 0 CD 0) which had the same value with NPK 1 CD 3 which were not statistically different (table III)

The calcium uptake in the roots shows significance ($p < 0.05$) with the control (NPK 0 CD 0) and NPK 2 CD 1 responding most to calcium retention and were not significantly different from each other in value. Again, NPK 0 CD 3, NPK 1 CD 2, NPK 2 CD 2 and NPK 2 CD 3 were also not significantly different at 5% probability level. There was however, a general trend throughout the study periods with the different fertilizer treatments. The least values were obtained from NPK 1 CD 3, NPK 3 CD 0 and NPK 3 CD 2 which were not significantly different from the mean of NPK 3 CD 1 (table III).

There were overall significant differences ($p < 0.05$) with magnesium root uptake. As observed with Ca, the control (NPK 0 CD 0) was comparatively highest in Mg uptake with

the same value as those treated with NPK 1 CD 2 and NPK 1 CD 3 with no significant differences among means. NPK 0 CD 1 was next in mean value (0.0022) and was significantly different from the general means of the other treatments resulting from its increased uptake at 8, 12, and 16 WAP and returned to its original value (as in 4 WAP). NPK 0 CD 3, NPK 2 CD 0, NPK 3 CD 0, NPK 3 CD 1, NPK 1 CD 1, NPK 2 CD 2, NPK 2 CD 3 and NPK 3 CD 3 were also not significantly different ($p < 0.05$). NPK 2 CD 1, NPK 0 CD 2, NPK 1 CD 0 and NPK 3 CD 2 recorded the least values and were also not statistically different from each other. It is also important to note that trend in response to the treatments were generally similar at the observed periods of the research (that is 4, 8, 12, 16 and 20 WAP).

NPK 1 CD 0 and NPK 1 CD 3 as well as NPK 2 CD 0 were not significantly different ($p < 0.05$). NPK 1 CD 1 and NPK 1 CD 2 were also not significantly different in Nitrogen uptake of the stems. The highest uptake values were obtained from NPK 3 CD 3, NPK 3 CD 2, NPK 3 CD 0 and NPK 3 CD 1 in that order. The control (NPK 0 CD 0) recorded the least nitrogen uptake closely followed by NPK 0 CD 2 and then NPK 0 CD 3 and NPK 1 CD 1. However, these were statistically different from the other. NPK 3 CD 3 was highest and gave a sharp difference in the uptake of phosphorus in the stem. NPK 2 CD 3 and NPK 0 CD 2 were not significantly different. The control (NPK 0 CD 0), NPK 1 CD 0 and NPK 1 CD 2 were also not significantly different from each other ($p < 0.05$) as do NPK 0 CD 3 and NPK 2 CD 2. This was also the case with NPK 1 CD 1 and NPK 1 CD 3 as well as NPK 2 CD 0 and NPK 3 CD 1 respectively (table IV). NPK 0 CD 1, NPK 0 CD 2 and NPK 1 CD 2 were observed not to be significantly different ($p < 0.05$). This was also the case of NPK 0 CD 3 and NPK 1 CD 0. The highest potassium uptake value was obtained from NPK 3 CD 2 (0.4110) and closely followed by NPK 2 CD 3 and NPK 3 CD 0 with the same mean (0.4100) value and were not statistically different from each other. The control (NPK 0 CD 0) recorded the least uptake value only different slightly from the others up to NPK 1 CD 3 then stepped up sharply at NPK 2 CD 0 stable at this point up to NPK 2 CD 2, again stepped up much more at point of NPK 2 CD 3 with same value as NPK 3 CD 0 which were marginally different from that of NPK 3 CD 2 with highest mean uptake value (table IV).

From table IV, it is generally observed that, stem calcium uptake is significantly different ($P < 0.05$) from each other. Only with NPK 1 CD 2 and NPK 1 CD 3 are not statistically different as well as NPK 2 CD 0 and NPK 3 CD 2. The highest uptake value was obtained from NPK 2 CD 3 closely followed by NPK 3 CD 1 and then NPK 2 CD 2. The control (NPK 0 CD 0) was average and the least from NPK 1 CD 1. This was the case

throughout the experimental periods as statistical comparison of the response with respect to weeks shows no significant differences indicating a perfect same trend throughout the periods of interest of the present study. There was a great deal of significant differences among treatments ($p < 0.05$) throughout the study periods. The trend was uniform at all periods of observation (4, 8, 12, 16 and 20 WAP) with the highest from NPK 2 CD 3 and the least obtained from NPK 0 CD 1 and NPK 1 CD 0 which were indeed not significantly different ($p < 0.05$). NPK 0 CD 3 and NPK 2 CD 0 were also insignificantly different from the other as in the case of NPK 1 CD 3 and NPK 3 CD 1 (table IV).

Conclusion

This study has shown that Cow dung contains a reasonably high content of Nitrogen, Phosphorus, Potassium, Sodium, Calcium, and Magnesium which are not toxic to *Irvingia wombolu* seedling. Co-Application of this animal waste (cow dung) with NPK fertilizer at higher levels (60 – 90g), NPK 3 CD 3, NPK 3 CD 2, NPK 2 CD 3 combination will best support the early growth response of *Irvingia wombolu* seedlings. The study also observed the pH of the soil sample from the Forestry and Wildlife Nursery unit of the University of Benin to be slightly acidic with soil texture apparently sandy-loam in nature (sand 85.0gkg^{-1}, silt 4.0 gkg^{-1}, clay 11.0 gkg^{-1}).

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

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