EFFECT OF POULTRY MANURE AND UREA FERTILIZER ON THE PERFORMANCE AND NUTRITONAL COMPONENTS OF *CORCHORUS OLITORIUS*

BY

SULEIMAN, Khadijat Omowumi

(12AE001727)

A DISSERTATION SUBMITTED TO THE DEPARTMENT OF CROP AND SOIL SCIENCES, COLLEGE OF AGRICULTURAL SCIENCES, LANDMARK UNIVERSITY, OMU-ARAN, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF SCIENCE (M.Sc.) IN CROP SCIENCE.

SEPTEMBER, 2021

DECLARATION

I, Omowumi, Khadijat, SULEIMAN, a M.Sc. student in the program of Crop and Soil Sciences, College of Agricultural Sciences, Landmark University, Omu-Aran, hereby declare that this dissertation entitled “Effect of poultry manure and urea fertilizer on the performance, proximate and some mineral components of *Corchorus Olitorius*” submitted by me is based on my original work. Any material(s) obtained from other sources or work done by any other persons or institutions have been duly acknowledged.

SULEIMAN, Omowumi Khadijat

12AE001727

CERTIFICATION

This is to certify that this thesis has been read and approved as meeting the requirements of the department of Crop and Soil Sciences, College of Agricultural Sciences, Landmark University, Omu-Aran, Nigeria, for the Award of M.Sc.

_________________________ ________________

Dr. Adekiya A.O Date

(Supervisor)

_________________________ ________________

Dr. Aboyeji C.M Date

(Co-supervisor)

_________________________ ________________

Dr. Alabi O.O Date

(Head of Department)

Prof. Fawole O.B ________________

(External Examiner) Date

DEDICATION

This report is dedicated to the Almighty God for His supernatural provisions and guidance. Also, to my mother for her endless love and support, may God bless you with long life and good health.

ACKNOWLEDGEMENT

I am eternally grateful to the Almighty God for His wisdom, knowledge, and understanding thus far.

I wish to express my heartfelt appreciation to my supervisor Dr. A.O. Adekiya and co-supervisor Dr. C.M Aboyeji for their patience, valuable contributions, and words of encouragement all through this project work.

I want to also express a profound gratitude to all staff of Crop and Soil Program, Faculty and Staff of College of Agriculture for their contribution in my academic journey. In particular, I appreciate the head of the Program, Crop and Soil Sciences and the College of Agricultural Sciences Post graduate coordinator, Dr. (Mrs) E.T. Alori and Dr. Joseph O. respectively. I am genuinely grateful for the contribution towards my success and for the constructive criticism during my research. I also want to appreciate the dean of school of post-graduate Landmark University Prof. Charity Aremu for her motherly guidance and mentorship all through my project work. To Dr. S.Z Hussain, I say a big thank you for your patience, tutorship, and mentorship throughout this project. The Lord bless you richly.

Much appreciation goes to my loving and supportive parents Mr. and Mrs. Suleiman and my wonderful brothers for the moral, spiritual, emotional and financial support. I love you all.

To my loved ones, colleagues and friends Blessing Tokula, Jesutofunmi, Oni Ayodele, Maku-Tade, Anobi Mathias, Ayeni Jerry, Sunny Wutem, Olarewaju Alex, Faith Okunlola, Ajani David. God bless you all and cause His face to shine on you and be gracious to you.

ABSTRACT

The use of inorganic fertilizer in Nigeria is limited by scarcity at the time of its need and high cost while poultry manure (PM) is cheap and readily available, rich in micro and macro nutrients apart from its high nitrogen constituents but it is limited by the bulkiness. Therefore, two field experiments were carried out at two different locations concurrently (Site A directly behind the poultry farm) and (site B directly opposite the screen house) in the cropping season of year 2020 at Landmark University Teaching and Research Farm, Omu-Aran, Kwara State. The results of site B was use to validate the result of site A. The experiment at both sites comprised of PM at six levels (100, 80, 60, 40, 20, and 0%), six levels of urea fertilizer (100%, 80 %, 60%, 40%, 20% and 0%) and the time of urea fertilizer application at three levels (1, 2, and 3 weeks after sowing (WAS)). The two experiments were laid out in a randomized complete block design with three replications which contained 17 treatments including the control to determine the sole and combined effects of poultry manure and urea fertilizer on the growth, yield, proximate and mineral contents of *Corchorus olitorius*. Results from this study showed that urea fertilizer and PM (sole or combined) increased growth (leaf numbers, stem diameter, number of branches and plant height), and the yields (whole yield, marketable yield and edible yield) parameters, proximate and mineral contents (K, Ca, Mg and P) of *C. olitorius* relative to the control. The results showed that sole application of PM alone at 100% increased growth parameters(stem girth, plant height, leaf numbers and number of leaves), mineral contents(Ca, K, Mg and P) of C. *olitorius* relative to the urea fertilizer alone applied at 1, 2 or 3 WAS compared with sole application of urea fertilizer alone (100%) either at 1, 2 or 3 WAS at both sites which can be attributed to the presence of micro and macro nutrients present in the PM and the fact that urea fertilizer is prone to losses by run-off, volatilization, leaching and/or denitrification. While inorganic fertilizer (applied either at

1, 2 or 3 WAS) increased carbohydrate, ash and moisture content of C. *olitiorius* compared with PM. PM increased these parameters relative to urea fertilizer applied either at 1, 2, or 3 WAS. In most cases, there were no significant differences in applying urea fertilizer to C. *olitorius* at 1, 2 and 3 WAS. The treatments, 60% PM + 40% urea fertilizer applied at 1 WAS produced the best growth parameters which are 49.55, 51.00 and 52.78 at weeks 4, 5 and 6 respectively for plant height, 7.14 and 7.37 at weeks 4 and 5 respectively for stem diameter, 89.11, 91.11 and 92.56 at weeks 4, 5 and 6 respectively for number of leaves, 15.11, 17.42 and 18.44 at weeks 4, 5 and 6 respectively for number of branches and treatment 80% PM + 20% urea fertilizer produced the best yield parameters (whole, marketable and edible yield). This could be ascribed to the synchrony in the time of availability of sufficient amount of N (nutrient) from urea fertilizer in the soil to the demand of the *C. olitorius* plant for uptake. In all, 40% poultry manure and 60% urea fertilizer applied at 2 WAS has the best values of proximate and mineral contents which are 7.12 and 1156.25 respectively of C. *olitorius*. Therefore, for those that desired to cultivate C. *olitorius* for its edible leaves application of 60% PM + 40% urea fertilizer applied at 1 WAS is recommended, however, for those that wants the quality of the C. *olitorius* leaves, 40% poultry manure and 60% urea fertilizer applied at 2 WAS is recommended.

TABLE OF CONTENT

LIST OF TABLE

LIST OF FIGURES

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to Study

Jute (*Corchorus olitorius* L) is a popular leafy vegetable that belongs to the family of Malvaceae. It is an erect annual herb that usually varies from 60 cm to almost 150 cm in height depending on the variety; the flowers are brightly yellow in small forms but are into clusters on the leaf's axils, forming a fruit in. The seeds are dull grey and also have four faces and one long apex, although they are rigged capsules. Jute is often cultivated in the tropics and warm temperate areas both for the leaves and the fiber in its stem. It is a plant that is widely distributed in subtropical and tropical regions of the world. It is a culinary and medicinal herb which is largely used as a vegetable in Asia and Africa. Egypt, Sudan, India, Bangladesh, the Philippines, Malaysia, and Japan are among the nations that consume the leaves.

Some of the most popular names for this species include Jute Mallow, Bush okro, Jew's Mallow. In Western African (Nigeria) the local names given to the species are *Ahihara* by the Igbo, *Malafiya* by the Hausa and *Ewedu* by the Yoruba.

With minimal heating, the succulent leaves of C. *olitorius* soften quickly and thicken into a viscous mucilaginous soup that may be consumed with starchy dishes made from the common staple root and tuber crops. The stem is the major source of jute, used in sack cloth, paper, and some other products. It's a light, soft wood that's used to make sulphur matches (Adediran et al., 2015). The young fruits and leaves are mostly eaten as a vegetable. The dried leaves are also used to make tea and as a soup binder. The seeds are also edible.

It is a leafy vegetable with high nutritional qualities and contains essential nutrients such as protein, calcium, phosphorus, iron, copper, and other significant components such as vitamins A, B complex, C, fiber, carbohydrate, fat, and a high calorific value (Schippers, 2000). It had been reported (Grubben and Denton, 2004; Harborne, Baxter and Moss, 1999) that the dry leaves of *C. olitorus* contain averagely about 4.8 grams of protein, 4.5 milligrams of iron, 4.7 milligrams of vitamin A, 15% dry matter, 259 milligrams of calcium, 92 milligrams of folates, per 100 grams of the leaves contains 105 milligrams of ascorbic acid and 1.5 milligrams of nicotinamide.

1.2. Statement of the Problem

Chemical fertilizer had been shown to enhance crop performance positively, (Agbede, Adekiya, Ale, Eifediyi and Olatunji 2019) but its usage in Nigeria is restricted due to high costs and unavailability when it is needed (planting season). Also, organic manure such as poultry manure (PM), has been proven to be beneficial in improving crop yield. When compared to chemical fertilizers, PM is inexpensive, widely available at most times, environmentally friendly and has a long lasting impact and has the potential to improve soil structure. The enormous amounts needed for large-scale crop production, however, restrict PM utilization (Adekiya, Agbede and Aboyeji, 2019). So to prevent these problems there is a strong advocacy for combining inorganic with organic fertilizers (Uwah and Iwo 2011). Organic manure and urea as a nitrogen source have been shown to have a beneficial interaction. (McRoberts2015).According to the study of Mani, Upadhyay, Kumar, Balak and Pathak (2011), employing locally accessible organic nutrient sources can improve efficiency and minimize the amount of chemical fertilizer needed.

1.3Justification

Generally for nutrient optimization using an integrated approach in *C.olitorius* production, PM is generally applied to the soil minimum of two weeks before planting (Uwah and Iwo 2011) in order to allow for poultry manure to decompose. Urea can be applied to *C. olitorius* farms at various phases of development. Delaying or applying urea to *C. olitorius* plants too early may have an impact on crop growth, yield, and quality. It was the opinion of many researchers (Adekiya, Ogunboye, Ewulo and Olayanju, 2020) that N should be applied when the crops need it most. Therefore, to increase the effective and efficient utilization of nitrogen fertilizer by *C. olitorius*, it is essential to determine the best application period during the integrated nutrient management of *C. olitorius* using urea fertilizer and PM. It is therefore important to determine the best time to apply urea fertilizer to the crop during its growth cycle in order to have best *C.olitorius* growth, yield, and quality.

1.4General Objectives

The main objective of this study was to investigate the effect of different rates of PM and time of applications of urea fertilizer on growth, yield and quality of *C. olitorius.* While the specific objectives were to: -

i. determine the effect of integrated application of PM and Urea fertilizer on growth and yield of *C.olitorius,*
ii. determine the best time of N fertilizer application that will optimize the growth, yield, and proximate compositions of *C.olitorius* and
iii. determine the effect of integrated application of PM and Urea fertilizer on mineral composition of *C.olitorius.*

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Geographical Distribution of Jute

C.olitorius has been grown in Asia and Africa for centuries, and it grows wild on both continents. Some scholars believe that *C.olitorius* and numerous other *C.olitorius* species originated in India or the Indo-Burmese region. However existence of more wild *C.olitorius* species in Africa, as well as more genetic variety within the genus, suggest to Africa as the genus's original center of origin, with the secondary center for diversification being in the Indo-Burmese area. *C.olitorius* is currently common across the tropics, and which is likely to be found in all nations of tropical Africa. It has been reported in many tropical Africa countries it can be wild or as a cultivated vegetable. *C.olitorius* is one of the popular highest leaf vegetables in Cameroon, Sudan Benin, Nigeria, Côte d'Ivoire Kenya, Uganda and Zimbabwe, it is also cultivated in the Caribbean, Brazil, India, Bangladesh, China, Japan, Egypt and the Middle East as a leaf vegetable, mainly cultivated for jute production in Asia (India, Bangladesh and China) together with *Corchorus capsularis* L., but here in Africa it is of no importance as a fibre crop, although the fibre may be used domestically.

2.2 Ecology and Soil Requirements

The best climatic condition for *C.olitorius* is between the temperatures of 25–32°C, annual rainfall of 600-2000mm, it grows mostly in grasslands, fallow and or unused land, which is mostly close to rivers, marshes, lakes up to about 1250-1750m attitude, this vegetable grows well in hot and moist condition, it is a short-day plant with day length of 12.5 hours produces considerably higher vegetative development as measured by the weight of stems, roots, and leaves not less than a day length of 11.5 hours, while a photoperiod of 11.5 hours resulted in higher fruit and seed output. Jute mallow requires organically rich sandy loam soils and does not grow well in thick clay.

Adediran, Ibrahim, Tolorunse and Gana (2015) reported that inadequate soil fertility, which results from denitrification, overgrazing, soil erosion, human activities and deforestation, is one of the primary problems of agricultural production in the tropics. Poor yield and yield quality indicate a lack of or insufficient soil nutrients for appropriate plant nourishment. (Aluko et al., 2014).

Jute mallow reacts well to fertilization, particularly nitrogen, according to several studies. Furthermore, this crop is primarily cultivated by marginalized producers for whom access to mineral fertilizers is challenging due to their low income. (Kate et al., 2020).

2.3 Poultry manure's effect on the growth and yield of Jute mallow

Application of organic amendments (poultry manure) has been shown to increase mineral availability in soil, particularly transporting nitrogen to crop plants from rangeland. Recently, a researcher has discovered that poultry manure is the most richly known farmyard manure giving higher levels of plant nutrients, particularly the droppings generated in a deep litter or cage house (Adekiya et al,.2019). Some studies have recently found that poultry dung has enhanced the leaf area, which contains total chlorophyll crops (Adekiya et al,.2020).

Adejoro (2011) also reported that poultry manure mineralizes faster than other animal manure such as cattle or pig dung; it therefore releases its nutrients efficiently for plant absorption and use. Poultry manure which is widely used for growing crops has been reported to enhance the growth and yield of *C. olitorius*.

In an old literature; there was a report that basic nutrients required for enhancing growth and yield of crops are contained in poultry manure. Poultry manure application increases water holding capacity, carbon content, decreases bulk density and aggregation of soil. The impact has an effect on increasing the exchangeable potassium and magnesium and water solubility which in turn enhance crop yield. Presently, in Sudan there are no particular recommended standards in relative to rate of poultry manure for enhancement of vegetables yield.

A field experiment containing four levels of poultry manure which are 0, 5, 10, and 20 tha^{-1} were used to carry out the experiment so as determine the effect on the growth and performance of jute of varying PM rates. The results showed that PM has a significant effect on all the growth attributes of jute mallow and resulted in an increase in crop yield as well as yield components in both seasons. From this study it was recommended that the highest poultry manure application rate which is 20 tha^{-1} is indispensible for vigorous growth and optimal increase in jute mallow under harsh semi-arid conditions of Sudan.(Naim, Ahmed and Ahmed 2015).

Another study looked at the impact of three types of organic fertilizers cow dung manure, goat manure, and poultry manure on the growth performance of *C.olitorius* (Ayeni and Oye, 2017). The various treatment concentrations employed were 1. 6 tha^{-1}, 3. 2 tha^{-1}, 4.8 tha^{-1}, and 7.2 tha^{-1}. The study found that 7.2 tha^{-1} of poultry manure caused the highest growth at 8 weeks after application.

The response of Jute (*C.olitorius*) to several types of organic manures was investigated in 2014 and 2015 cropping seasons at the Teaching and Research Farm of the Taraba State College of Agriculture. The treatments included 3.0 tha^{-1} of each of four organic manures: chicken droppings, sheep manure, goat manure, and cow dung, with a control (no organic manure). The results showed that these organic manures boosted the performance of Jew's mallow, with poultry manure having a superior benefit over other forms of manures (Garjila, Shiyam and Augustine ,2017). Plants in this treatment were significantly ($p = 0.05$) taller (85.0/84.8 cm) with more leaves and produced the highest fresh leaf yield of 15,666.7 and 15,623.2 kg/ha in the cropping season of 2014 and 2015, respectively, recommending that applications of 3.0 tha^{-1}poultry manure could be used to maximize the yield of *C.olitorius* for enhanced yield benefit farmers in the study area.

2.4 Effect of urea application on the growth and yield of *C. olitorius*

Nitrogen is part of the essential nutrients needed for plant growth and thus it deficiency can easily be noticed and traced to disease and low yield symptoms. Therefore there is need for the study on the effect of nitrogen in relative to *C.olitorius.*

Another study was conducted to determine the influence of nitrogen fertilizer on the growth and yield of Jute mallow morphotypes. The highest N fertilizer rates had the greatest influence on plant height, plant branching, pod number per plant, and yield weight per plant in morphotypes

GT and BT, respectively Morphotypes GT and BT had the lowest plant height, branching at the main stem, pods, and leaf weight per plant when no N fertilizer was applied(Ghazi, 2018).

An experiment was conducted on a leafy vegetable *Amaranthus cruentus* by Christopher, Adefolaju and Ajibade (2016) in Minna, Nigeria, using standard rates of cow dung (16 t ha^{-1}); NPK (0.25 t ha^{-1}) and control (no fertilizer) were administered to a 5 X $5m^2$ plot using randomized complete block design (RCBD) with three treatments and three replicates. Parameters measured were plant height, leaves number, biomass and edible yield and were subjected to statistical analysis using SPSS 16.1 version at 95% level of significance. Final biomass yield of the vegetable for cow dung, N.P.K and control were 30,667±5.22 kg ha^{-1}, 60,408± 2.45 kg ha^{-1} and 46,825± 10.22kg ha^{-1} respectively while edible yield were 11,125 ±5.54 kg ha^{-1}, 20,925±6.43 kg ha^{-1} and 11,092±3.33 kg ha^{-1}. Agronomic responses to the three treatments 7 weeks after planting (WAS), 18.83±2.30 cm for cow dung, 23±2.75 cm for the NPK and 17.75±2.40 cm for the control respectively. Plant height responses to the treatment were 70.08±5.45 cm for cow dung, 108.42±5.89 cm for NPK and 89±1.32 cm for control respectively in the same WAS. NPK was outstanding in all treatments during the experiment going by the responses. Usage of raw cow dung was not encouraged due to the possibility of Escherichia coli (foliage contamination) and NPK has proved to be the most suitable fertilizer.

Olaniyi and Ajibola (2008) reported that Nitrogen fertilizer influences the growth, yield parameters positively and dried weight using potted experiment in determining the optimal rates of nitrogen and phosphorus fertilizer application for maximum *C. oliotrius* plant development and seed yield. The Oniyaya and Amugbadu varieties of *C. oliotrius* were each given five rates of nitrogen (0, 15, 30, 45, and $60Nkgha^{-1}$) and phosphorus (0, 10, 20, 30, and -1 40 P2O5 $kgha^{-1}$) fertilizers. The outcome indicated that single application of P and N improved height of plant, leaf numbers, dry matter, fresh shoots and seed yields of *C. oliotrius* in both varieties significantly above the control (no amendment). Oniyaya had the best performance when compared, while the Amugadu had the highest in the terms of shoot and yield of seeds.Iit was concluded that this could be because Nitrogen positively influences the yield of the *C. oliotrius* varieties used for the experiment.

2.5 Combined effects of poultry manure and urea on the growth, yield and mineral constituent of *C. olitorius*.

In a completely randomized design, a pot experiment was conducted to determine fertilizer at different combinations as follows; (100% + 0%), (20% + 80%), (40% + 60%), (60% + 40%), (80% + 20%) and (0% + 100%) for treatments 1-6 respectively. The NPK fertilizer had effect on the growth of the plants until they reached a specific stage of development. All of the plants treated exclusively with chicken manure or in combination with inorganic fertilizer yielded the most edible leaves, as well as robust and healthy stems capable of supporting the top parts. At p 0.01, the treatments containing some poultry manure produced plants and pods with higher weights than those treated with 100 percent inorganic fertilizer. As a result, either alone or in combination with inorganic fertilizer, PM enhanced *C.olitorius* production.(Mogapi, Mathowa, Mpofu, Stephen and Machacha, 2013)

Ayinla et al,.(2018) carried out a study aimed at examining the effects of different concentrations of inorganic, organic, and organo-mineral fertilizers on growth, nutritional content and yield of *C.olitorius*. A fully randomized block design with three replicates was used in the experiment. Control, treatments which are 2,000 $kgha^{-1}$ single PM, 1,000 $kgha^{-1}$single poultry manure (PM), 400 $kgha^{-1}$single NPK, 600 $kgha^{-1}$ single NPK, 200 $kgha^{-1}$ single NPK,200 $kgha^{-1}$ NPK +1,000 $kgha^{-1}$ PM, 600 $kgha^{-1}$ NPK +1,000 $kgha^{-1}$PM, 400 $kgha^{-1}$ NPK +1,000 $kgha^{-1}$ PM fertilizer combinations, 2,000 $kgha^{-1}$ PM+200 $kgha^{-1}$ NPK,400 $kgha^{-1}$ NPK + 2,000 $kgha^{-1}$ PM. In comparison to controlled plots, the yield, growth, and nutritional content of *C. olitorius* plants were considerably improved in all plots treated with fertilizers. When compared with other application combinations, plots that were treated with a combined application of inorganic and organic fertilizers at the rate of 400 $kgha^{-1}$ NPK+2000$kgha^{-1}$ PM and600 $kgha^{-1}$ NPK +2,000 $kgha^{-1}$ PM had significantly higher growth metrics, yield, and nutritional composition. In compared to solo application of either fertilizer, this study confirms that combining soil amendments either in form of organic and inorganic fertilizer has a great effect on the improvement of *C.olitorius* growth, yield, and nutritional content.

Similarly, during the rainy season of 2014, another field experiment was conducted at the Federal University of Technology's teaching and research farm in Minna, Niger State, Nigeria, to determine the influence of various nutrient sources on the growth, production, and quality of

C.olitorius. A randomized full block design was used in the experiment. The treatments used are: control (no amendment), 8 t/ha poultry manure, organo-mineral fertilizer (125 kg NPK 20:10:10 + /ha 4 tha^{-1} poultry manure), with 250 kg 20:10:10 NPK fertilizer. It was reported in this study that the varied nutrition sources had a substantial impact on all of the parameters examined. Plants that got poultry manure had the largest leaves and stems. Plants on plots that were treated with inorganic (NPK) and organic fertilizer (PM) show no significant difference, control plants had the lowest values of all the growth parameters examined. Plants that were treated with poultry manure had the highest values for the dry matter and fresh yield followed by plant that received the NPK fertilizer, whereas the control plants had the lowest. Plants treated with poultry manure had the highest crude protein and phosphorus levels, whereas the control plants had the lowest levels according to the report. In plants that received poultry manure and NPK fertilizer, the values of ash, potassium, sodium and moisture content reported for these plants and poultry manure showed no significant changes. The mucilaginous content of plant that were treated with poultry manure was higher than those which were not. Adediran et al; (2015) concluded that poultry manure appears to be a better option for jute mallow production.

The chemical analysis of soil that had been treated with poultry manure and NPK fertilizer a year prior to being planted with *C.olitorius* was performed at Akure, southwest Nigeria, the residual result of the treatments on *C.olitorius* plant was evaluated. The addition of poultry manure to the soil were said to enhanced organic matter, as well as N, P, K, Ca, and Mg. The soil component values resulting from the use of poultry manure were greater than those resulting from inorganic fertilizer applications. Total fresh yield, edible yields and marketable yields of *C. olitorius* were all improved in plots initially treated with chicken manure, notably at 30-50th^{-1}.(Adenawoola and Adejoro 2005).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1. Description of Experimental Site

Two field experiments were conducted concurrently (sites A directly behind the poultry pen and B directly opposite the screen house) in year 2020 at the Teaching and Research Farm of Landmark University Omu-Aran, Kwara state which has a Latitude 8'8°N and longitude 5'6°E located in the derived savannah region of Nigeria. Experiment in Site B was conducted so as to validate the result of site A.Omu-Aran has annual rainfall pattern which extends between the months of April and November with an average of 1300 mm, having it's peak rain in June and October. The mean annual temperature is about 32°C.The dry season commences by December and ends in March.

3.2. Source of Poultry manure

The poultry manure used for this study was collected from broiler section of poultry division of Landmark University Teaching and Research Farm Omu- Aran, Kwara State. The poultry manure (PM) was cured for two (2) weeks in order to allow for mineralization of the poultry manure into the soil.

3.3. Treatment and Experimental Design

3.3.1. Experimental design and treatment

The experiment at both sites comprised of poultry manure (PM) at six levels (100% ,80%, 60%, 40%, 20,% and 0% control), six levels of urea fertilizer (100%, 80 %, 60%, 40%, 20% and 0% control) different combinations of PM and urea fertilizer and time of urea fertilizer application at three levels (1, 2, and 3 weeks after sowing) and all replicated three times in a Randomized Complete Block Design (RCBD). The sole application of PM or urea and the combinations and time of urea application altogether gave 17 treatments, namely;

Treatment 1- control (No amendment)

Treatment 2- 100% of PM.

Treatment 3- 80% of PM + 20% urea fertilizer applied at 1 Weeks after planting.

Treatment 4- 80% of PM + 20 urea fertilizer applied at 2 Weeks after planting.

Treatment 5- 80% of PM + 20urea fertilizer applied at 3 Weeks after planting.

Treatment 6- 60% of PM + 40% urea fertilizer applied at 1Weeks after planting.

Treatment 7-60% of PM + 40% urea fertilizer applied at 2 Weeks after planting.

Treatment 8- 60% of PM + 40% urea fertilizer applied at 3 Weeks after planting.

Treatment 9 – 40% of PM +60% urea fertilizer applied at 1 Weeks after plant.

Treatment 10- 40% of PM +60% urea fertilizer applied at 2 Weeks after planting.

Treatment 11- 40% of PM + 60% urea fertilizer applied at 3 Weeks after planting.

Treatment 12- 20% of PM + 80% urea fertilizer applied at 1 Weeks after planting.

Treatment 13- 20% of PM + 80% urea fertilizer applied at 2 Weeks after planting.

Treatment 14- 20% of PM + 80% urea fertilizer applied at 3 Weeks after planting.

Treatment 15-0 % of PM +100% urea fertilizer applied at 1 Weeks after planting.

Treatment 16- 0 % of PM +100% urea fertilizer applied 2 Weeks after planting.

Treatment 17- 0 % of PM +100% urea fertilizer appliedat3 Weeks after planting.

Organic manure (PM) were applied at the rate of 120 kg N ha^{-1}. Equivalent values for PM were

1.71 kg for 100 %PM

1.36 kg for 80% PM

1.02 kg for 60 % PM

0.68 kg for 40 % PM

0.34 kg for 20 % PM

Equivalent values for urea fertilizer were

100g for 100%

80 g for 80 %

60 g for 60%

40 g for 40%

20 g for 20%

3.3.2. Plot Size

There were 17 plots per replicate. The land was marked out to plots of 2 m × 2 m, alley way of 1m was left between each replicate and 0.5 m in between plots.

3.4. Seed type

The seed variety used for the experiment was one of the local variety called "Oniyaya".

3.5. Cultural Practices

3.5.1. Preparation of land: - This was done mechanically, after plowing the field once using a tractor-drawn disc plough and harrowed; it was then harrowed twice and divided into plots of 1m x 1m, and 0.5 m spacing. Later, the field layout was carried out to mark number of treatment plots

3.5.2. Fertilizer application: - The PM was incorporated at 1.71kg-100%, 1.36kg- 80%, 1.02kg-60%, 0.68kg-40%, 0.34kg-20%, and 0 % per plot using hoe. The manure was thereafter left for two weeks to mineralize before sowing *C. olitorius* seeds while the Urea fertilizer was applied at 1, 2 and 3 weeks after sowing (WAS) the *C.olitorius* at a rate of 120 kg nitrogen per hectare which translates into 100g, 80g 60g, 40g and 20g respectively for 100%, 80%, 60%, 40% and 20% Urea fertilizer using band method.

3.5.3. Sowing: - The seeds were sown manually by drilling, dry soil was mixed with the seeds before drilling to make sure that seed were not compacted together, between rows seeds were sown 10 cm. Germinated plants after 7 days of sowing were thinned to one (1) plant/ stand and a distance of 10cm between the plants.

3.5.4. Weed control: Pre-emergence herbicide (Metolachlor) suitable for all types of weed was applied using a knapsack sprayer at the rate of 1.5 kg a.i ha^{-1}immediately after sowing the seed and manual weeding was employed throughout the growth stage of *C. olitorius*.

3.6. Observation and Data Collection

3.6.1. Growth parameters

a) Plant height (cm): - The height of the representative plants in each plot were measured at 4,5 and6 weeks after planting tape rule was used from the base of the plant to the highest growing point's tip, and the average recorded

b) Number of leaves: - this was carried out within a period of 4, 5 and 6 weeks after sowing. Number of the leaves from each of the three tagged plants per plot was counted and recording the mean.

c) Stem diameter(cm): - This was determined at interval of 4, 5 and 6 weeks by measuring the diameter of the representative plant per plot using a vernier caliper and the recording the mean.

d) Number of Branches:-At the interval of 4, 5 and 6 weeks. Number of branches was counted on each representative plant per plot.

(e) Total biomass (g): - This was determined by weighing the representative plant per plot immediately after harvesting using the weighing balance of to determine the whole weigh.

3.6.2. Yield parameters

a) Marketable weight (g): - This was determined by weighing the representative plant per plot immediately after harvesting on field.

b) Edible Yield: - This was determined by separating the leaves from the stem of the representative plant per plot immediately after harvesting on field and weighing the edible parts (the leaves).

3.7. Laboratory Analysis

3.7.1 Initial soil sample test

Particle size analysis was determined with the use of hydrometer method as described by Rowell (2014). Fifty grams of 2 mm sieved soil were weighed into 250 ml conical flasks and 50 ml of 5% sodium hexametaphosphate solution (calgon solution) was added and left for 15 minutes to disperse. One hundred millilitron of distilled water were added to the soil sample and left till the following day. The mixture was quantitatively transferred into a dispersing cup and dispersed using a mechanical stirrer for 10 minutes. The mixture was immediately transferred to 1000 ml measuring cylinder. The dispersing cup was rinsed into the measuring cylinder until there was no trace of soil particle in the cup. Thereafter water was added to fill the cylinders up to 900 ml mark and hydrometer was inserted into the cylinder before adding water to 1000 ml mark. After the hydrometer was removed, cylinder was tightly covered carefully to avoid leakage and the content was thoroughly mixed by inverting the cylinder several times. The cylinder and the content were placed on the laboratory table and the stop watch was immediately set to take count of the time. At about 40 seconds the hydrometer was gently inserted into cylinder and at 40seconds hydrometer reading was taken. Immediately after the hydrometer reading, the temperature of the dispersing medium was also taken. Both the hydrometer and temperature reading were recorded (first readings). After 2 hours, the temperature and the hydrometer readings were taken again for the second readings. The percentages sand, clay and silt content in the soil were calculated using the formula below:

% Sand = 100 – (first reading + corrected temperature reading) x 100
Weight of soil

% Clay = (second reading + corrected temperature reading) x 100
Weight of soil

% Silt = 100 - (% sand + % clay)

The soil pH was determined in water (1:2 soil to water ratio) and in 1N potassium chloride (1:2 soil to solution ratio) using a digital pH meter. The organic carbon was determined by the

Walkley-Black method on soil samples reduced to 0.5mm particle size (Walkley and Black, 1934) as described by Nelson and Sommers (1996).

The available P was determined according to the method of Frank et al. (1998) by using Bray-1 extractant at a soil: extractant ratio of 1:5. The exchangeable bases (K, Ca, Na and Mg) were extracted using normal neutral ammonium acetate (Hendershot et al., 2007). 5 grams of 2 mm sieved soil sample was weighed into sample bottle and 50 mL of ammonium acetate (pH 7.0) was added. The solution was shaken on mechanical shaker for an hour, allowed to settle and filtered. The exchangeable sodium (Na^+) and potassium (K^+) content of the filtrates were determined by flame photometer while the exchangeable calcium (Ca^+) magnesium (Mg^+) were read on Atomic Absorption Spectrophotometer (AAS).

3.7.2. Proximate analysis of *C. olitorius* leaves

Proximate analysis of leaves of *C. olitorius* was carried out in Landmark University's Soil and Crop Science Laboratory. The dried samples of leaves were grounded and then these analyses were carried out for ash content, crude fat, crude fibre, crude protein and moisture content with the use standard chemical methods compiled by the Association of Analytical Chemists (AOAC, 2010).

3.7.3. Crude Fat

About 150ml of anhydrous diethyl ether (petroleum ether) of boiling point of 60-80ºC was placed in the flask. Two (2g) of the samples were weighed into a thimble which was plugged with cotton wool. The thimble with content was placed in the extractor; the ether in the flask is then heated for 4 hours. After extraction the samples were weighed.

$$\%\text{Crude Fat} = \frac{\text{wt. of sample- wt. of extract}}{\text{Wt. of sample}} \times 100.$$

3.7.4. Crude Fibre

After the sequential extraction of the samples using ether in order to determine the crude fibre content. The samples without fat were moved100ml of pre-heated 1.25 % H_2SO_4 was added to the flask/beaker, and the solution was gently heated for 30 minutes, maintaining a constant volume of acid by adding hot water. The buckner funnel flask which was fitted with whatman filter which was already heated a little by adding hot water into the funnel, after which the residue was rinsed very well with boiling water (until the neutral to litmus paper) and then poured back into the beaker. Later 100ml, 1.25% NaOH was added which was already pre-heated and then allowed to heat up for another 30 minutes, it was filtered under suction and rinsed thoroughly with hot water twice and ethanol. Residue was left to dry up at 65^0C for about 20 minutes and then weighed again; it was placed in burning furnace (400-600^0C) for ash after it was poured into a crucible and later placed in muffle furnace, followed by weighing.

$$\% \text{ Crude Fibre} = \frac{\text{Dry weight.of residue before ash} - \text{Wt. of residue after ash}}{\text{Wt. of sample}} \times$$

3.7.5. Crude protein

Crude Protein was determined by measuring the nitrogen content of the sample and multiplying it by a conversion factor of 6.25%, the crude protein was determined by Kjeldahl method. The apparatus used for digestion was the Foss digester. The samples (2grams) each was weighed into Kjeldahl tube, then concentrated Tetraoxosulphate (vi) acid (25ml) was added into the Kjeldahl tube with samples, 0.5grams each of copper sulphate and 5grams of sodium sulphate with a little of selenium tablet were added, following digestion. Foss distillation apparatus was used for distillation. After distillation the sample was titrated with 0.1N HCl and the titre value was recorded. The formula used for calculating crude protein is as follows;

$$\%N = \frac{T - B \times 0.1 \times 14.007 \times 100}{1000}$$

Where B= blank, T=Tire value of the sample

Therefore, % crude protein =%N × 6.25

3.7.6. Total Ash

Ash was determined by weighing 2g of the samples in crucible and subjecting it to heat inside a muffle furnace at 550^0C for 4 hours. The crucible was then placed in the desiccators to cool and later weighed.

$$\% \text{ Ash} = \frac{\text{Wt. of crucible+ash-Wt.ofcrucible}}{\text{Wt. of sample}} \times 100$$

3.7.7. Moisture Content

This was determined by gravimetric method. Two (2g) of fresh samples were placed in the oven at 105^0c for 24 hours. Then, the final weights were also measured.

$$\% \text{ Moisture} = \frac{\text{Initial weight-Final weight} \times 100}{\text{Initial weight}}$$

3.7.8. Nitrogen determination

The Kjeldahl digestion and distillation method as described by Partey (2010) was used to determine the total Nitrogen. After oven drying the sample 1 gram of the sample was weighed and ground, the it was placed in a Kjeldahl flask and added 0.7g of copper sulphate, 1.5g of K_2SO_4andH_2SO_4. The solution was heated gently until frothing ceases and later boils until the solution was clear which was allowed to digest for thirty (30) minutes, left to cool down, 50ml of water was poured and then transferred into a distilling flask before 30ml of0.05MH_2SO_4(standard acid)the poured into a conical flask adding 2 drops indicator (methyl red) was poured in the receiving conical flask with the addition of 2 drops of methyl red indicator and water added. In the distilling flask, thirty (30) milliliters of 35% NaOH was poured using a method that the content will not mix up. Contents were boiled for about 30 minutes in order to distil excess ammonia acid in the distillate then titrated against NaOH (0.1M)and the Nitrogen constituents of the sample was calculated as;

$$\text{Percentage nitrogen} = \frac{1.401(V_1M_1\text{-}V_2M_2)\text{-}(V_3M_1\text{-}V_4M_2)}{W} \times \text{ df}$$

V1= Volume of acid in receiving flask for samples;

V2= Volume of NaOH used in titration;

V3= Volume of acid in receiving flask for blank

V4= Volume of NaOH used in titrating for blank

M1= Molarity of acid;

M2= Molarity of NaOH;

W= Weight of sample

Df=Dilution factor of sample.

3.7.9. Calcium and Magnesium Determination

EDTA titration was used for the determination of calcium and magnesium. One gram (1g) of ground oven-dried sample was dry ash in a muffle furnace, after which the ash was dissolved with 2ml of 2N HCl and was filtered after 20 minutes into a volumetric flask and fill with distilled water up to 100ml. In Ca + Mg determination, 20ml was taken into conical flask and 100ml of distilled water, 15ml of concentrated ammonia solution, 10 drops of 2%KCN and 10 drops of 5%Hydroxyl ammonium chloride ($OHNH_3Cl$). The solution was titrated with 0.01M EDTA using Eriochrome as indicator. To determine Ca content alone, 20ml of the solution was taken into the conical flask and 100ml of distilled water, 10ml of 20% KOH, and a pinch of calcine indicator. The solution was titrated with 0.01EDTA.The difference between the first and the second titres represents magnesium concentration in solution.

3.7.10. Phosphorus Determination

Phosphorus was determined in the ash solution (as described for C + Mg above) using spectrometric analysis. Five (5) millilitres of sample, 4ml of 0.53 ascorbic acid, and 25ml of distilled water was taken and place in the spectrometer reading at 660mm wavelength for Phosphorus. 4ml of 0.53 ascorbic acid and 25ml of distilled water was used to conduct the blank test. Total Phosphorus in the sample was determined as;

$$P=\frac{A-B}{0.1987} \times 35$$

A= Phosphorus obtained

B= Value obtained from the blank test.

3.7.11. Potassium Determination

Potassium in the ash solution (as described for P above) was determined using flame photometer. This instrument is an analytic device that uses the basic principles of spectrometry for qualitative analysis.

3.8. Data Analysis

All collected data were subjected to analysis of variance using Statistical package for social sciences S.P.S.S. These treatments means were compared using Duncan Multiple Range Test (DMRT) at 0.05 level of probability.

CHAPTER FOUR

4.0 RESULTS AND DISSCUSSION

4.1 RESULTS

4.1.1. Physical and chemical properties of soil from the experimental sites prior to planting and analysis of poultry manure used for the study

The result of the soil physical and chemical properties of experimental sites prior to planting and analysis of poultry manure that was used in the study are presented in the Tables 1 and 2 respectively. The soil was mainly sandy loam, containing 16.5% of silt at both sites, clay 15.4 % and 15.3% at site A and site B, respectively, slightly acidic with pH of 5.72 at both sites and both low in organic manure, Nitrogen (N), Phosphorus (P), Potassium (K) and Magnesium (Mg) but moderate in Calcium (Ca) according to the critical value of 3.0% OM, 0.20% N, 10.0 mg kg^{-1} available P, 0.16–0.20 cmol kg^{-1} exchangeable K, 2.0 cmol kg^{-1} exchangeable Ca, and 0.40 cmol kg^{-1} exchangeable Mg recommended for crop production in ecological zones of Nigeria (Akinrinde and Obigbesan, 2000).It was found that poultry manure is high in major nutrients required for the growth of fruit crops such as *C. olitorius*. The poultry manure's macro and micro nutrient contents are expected to enhance the soil fertility, improve the soil structure and improve the performance of *C. olitorius.*

Table 1: Soil properties prior experimentation

Property	Site A	Site B
Sand (%)	68.1	68.2
Silt (%)	16.5	16.5
Total N (%)	0.14	0.14
Organic matter (%)	1.92	1.92
Total N (%)	0.14	0.14
Organic matter (%)	1.92	1.92
Exchangeable Ca (cmol kg^{-1})	2.41	2.39
Exchangeable Mg ($cmolkg^{-1}$)	0.36	0.33
Exchangeable K ($cmolkg^{-1}$)	0.15	0.33
pH (water)	5.72	5.72
Clay (%)	15.4	15.3

Table 2: Analysis of poultry manure used for the study

Property	Value
Mg (%)	0.57
Organic C (%)	21.5
Mg (%)	0.57
K (%)	1.80
P (%)	1.35
N (%)	2.91
pH (water)	6.80
C: N	7.38

4.1.3. Effect of Poultry manure and Urea fertilizer on plant height

Table 3 shows the effects of organic and inorganic fertilizers on the plant height at site A and site B. It was observed that plant height increased significantly ($p = 0.05$) across all the treatments compared to the control at both sites. Poultry manure alone at 100% significantly increased plant height than urea fertilizer alone (100%) either at 1, 2 or 3 weeks after planting at both sites. Application of poultry manure at 60% and urea at 40% at 1 week after sowing *C. olitorius* increased plant height relative to other applications either poultry manure alone, urea alone or combined treatments at both sites. Application of urea fertilizer at 1 week after sowing *C. olitorius* seeds increased plant height significantly compared to week 2 and 3 applications. The order of increase in plant height was week 1 < week 2 < week 3. Also, there was a progressive increase in the plant height across week 4, 5 and 6 for the growth parameters at both sites.

Table 3: Effects of poultry manure and urea fertilizers on plant height of *C.olitorius* at site A and site B

		4 WAS		5 WAS		6WAS	
PM (%)	Urea fertilizer (%)/time application (week)	SITE A	SITE B	SITE A	SITE B	SITE A	SITE B
Control		8.03h	6.67h	9.84g	8.00g	11.78j	9.33hi
100	0	32.00de	33.19a	33.67de	34.77a	35.22de	36.22a
80	20 @1	38.67bc	30.78ab	40.33bc	32.33ab	42.22bc	34.11ab
	20 @2	32.86de	22.99d	34.22de	24.56c	35.89de	26.34d
	20@ 3	30.77bc	16.22de	32.56de	17.78d	34.22de	19.33e
60	40 @1	49.55a	27.89bc	51.00a	29.22bc	52.78a	30.89bc
	40@ 2	44.55ab	22.45d	45.99ab	24.00c	47.56ab	25.57d
	40@3	33.86cde	10.11f	35.89cd	19.56d	37.67d	20.67e
40	60 @ 1	35.55cd	28.45bc	37.11bc	30.11bc	38.78d	31.56bc
	60 @ 2	32.22de	28.22bc	32.34de	29.89bc	35.34de	31.44bc
	60 @ 3	30.55ef	13.89e	28.67ef	15.11de	33.78ef	16.22f
20	80 @ 1	30.11ef	8.11g	31.67de	10.11ef	33.33ef	11.11gh
	80 @ 2	24.44f	18.11de	29.33efg	19.78d	28.22fg	21.33e
	80 @ 3	20.66fg	12.22e	21.78ef	13.00de	22.78h	14.00fg
0	100 @ 1	19.33fg	8.33g	21.33ef	9.33ef	23.11h	10.22gh
	100 @ 2	17.11fg	5.67h	18.78fg	7.00fg	18.55i	7.89ij
	100 @ 3	10.00g	4.00h	12.00g	5.22h	14.00ij	4.89j

Values followed by similar letters under the same column are not significantly different at

p= 0.05 according to Duncan's multiple range test.

4.1.4. Effect of poultry manure and urea fertilizer on the stem diameter of *C.olitorius*

Table 4 shows the effects of PM and urea fertilizers on the stem diameter at site A and site B. All amended treatments (except 0% PM and 100% urea fertilizer applied at 2^{nd} and 3^{rd} weeks after sowing (WAS)) increased stem diameter significantly ($p = 0.05$) relative to the control. Application of poultry manure at 60% and urea at 40% at week 1 seems to produce the widest stem diameter across the two sites. Application of urea fertilizer at 1 week after sowing C. *olitorius* seeds increased stem diameter relative to week 2 and 3 applications. Also, the order of decrease in the stem diameter was week 3 > week 2 > week 1. Also, there was a progressive increase in the stem diameter across week 4, 5 and 6 for the growth parameters at both sites.

4: Effects of poultry manure and urea fertilizers on the stem diameter of *C.olitorius* at site A and site B

		4WAS		5WAS		6WAS	
PM (%)	Urea fertilizer (%)/time application (week)	**SITE A**	**SITE B**	**SITE A**	**SITE B**	**SITE A**	**SITE B**
Control		3.95d	2.00ef	6.33ab	2.70ef	5.19ef	2.86de
100	0	5.30bc	6.30a	5.32bc	6.68a	9.48bc	6.88a
80	20 @1	6.38ab	6.04ab	6.15ab	6.06ab	13.88a	6.26ab
	20 @2	6.34ab	6.01ab	6.43ab	6.12ab	10.97ab	6.25ab
	20@ 3	6.39ab	4.43cd	6.96ab	4.82cd	10.58ab	5.63bc
60	40 @1	7.14a	6.00ab	7.37a	6.13ab	11.20ab	6.38ab
	40@ 2	6.35ab	4.80cd	6.29ab	4.98cd	13.90a	5.04bc
	40@3	5.81bc	2.20ab	6.08ab	2.37ef	10.83ab	4.39bc
40	60 @ 1	6.40ab	5.63bc	6.69ab	5.78bc	10.17ab	6.08ab
	60 @ 2	5.33bc	5.56bc	5.44bc	5.78bc	10.68ab	5.97bc
	60 @ 3	6.38ab	3.65d	6.56ab	3.70de	10.94ab	3.82cd
20	80 @ 1	6.33ab	3.46d	5.48bc	3.58de	10.24ab	3.90cd
	80 @ 2	5.93ab	2.87e	6.33ab	2.91ef	7.44de	3.80cd
	80 @ 3	3.86d	2.58e	4.04cd	2.63abc	4.39a	2.56de
0	100 @ 1	5.59bc	5.10bc	6.10ab	5.69bc	8.01cd	5.76bc
	100 @ 2	4.06cd	2.12e	5.66bc	2.46ef	4.78f	3.40cd
	100 @ 3	3.42d	1.54f	4.56cd	2.18f	5.79ef	2.31de

Values followed by similar letters under the same column are not significantly different at p= 0.05 according to Duncan's multiple range test.

4.1.5. Effects of poultry manure and urea fertilizers on the number of leaves of *C.olitorius* plant at both sites.

The results of the effects of poultry manure and urea fertilizers on the number of leaves are presented in Table 5.Amended treatments increased number of leaves of *C. olitorius* significantly compared with the control (except for urea fertilizer alone applied at 2 and 3 WAS). Among all treatments, 60%PM and 40% urea fertilizer applied at 1 WAS increased number of leaves most at site A whereas, it was 100% PM that increased number of leave most at site B. Also, week of application of urea fertilizer increased number of leaves in C. *olitorius* with week 1 having significantly higher values compared with week 2 and 3 at both site A and site B. Furthermore, there was a progressive increase in number of leaves from 4^{th} week to 6^{th} week for the leaf numbers.

Table 5: Effects of poultry manure and urea fertilizers on number of leaves of *C.olitorius* plant at both sites.

		4WAS		5WAS		6WAS	
PM (%)	Urea fertilizer (%)/time application (week)	SITE A	SITE B	SITE A	SITE B	SITE A	SITE B
Control		33.67de	10.43ef	35.89fg	20.00g	37.78e	21.33i
100	0	63.89cd	45.06a	54.22de	84.22a	63.89bc	85.89a
80	20 @1	63.55cd	34.23b	65.33cd	67.66b	66.78b	69.33b
	20 @2	58.78de	28.87bc	60.44cd	53.86c	61.89bc	55.56cd
	20@ 3	55.89de	13.87e	58.78de	39.56e	60.67bc	41.22e
60	40 @1	89.11a	31.49bc	91.11a	69.22b	92.56a	70.78b
	40@ 2	61.89cd	30.26bc	63.56cd	48.45d	67.11bc	50.11d
	40@3	54.33ef	25.44c	56.11de	48.67d	57.56cd	49.78d
40	60 @ 1	60.56cd	35.34b	63.44cd	67.66b	65.00b	69.00b
	60 @ 2	51.11fg	33.16b	53.11de	56.76c	54.67cd	58.33cd
	60 @ 3	49.22fg	16.91d	51.11de	34.00ef	52.89cd	35.22f
20	80 @ 1	79.45ab	27.00bc	81.11ab	33.44ef	82.65ab	35.11f
	80 @ 2	68.89bc	11.33ef	71.00bc	30.33f	72.33ab	31.45fg
	80 @ 3	36.67h	3.92h	38.00f	18.44h	39.00e	19.67i
0	100 @ 1	52.22fg	9.88fg	54.11de	13.67j	55.89cd	14.89j
	100 @ 2	30.11de	9.21fg	32.00fg	16.78h	33.56e	18.00i
	100 @ 3	21.67e	7.22g	23.67g	14.44ij	25.56f	15.67j

Values followed by similar letters under the same column are not significantly different at

p= 0.05 according to Duncan's multiple range test.

4.1.6. Effects of poultry manure and urea fertilizers on the number of branches of *C. olitorius* plant at both sites.

Results of the effects organic and inorganic fertilizers on the number of branches at site A and site B are shown in Table 6. These results shows a difference significantly at p = 0.05 between all treatments and the control except for urea fertilizer alone applied at 1, 2 and 3 weeks after sowing treatment. 60% poultry manure and 40% urea applied at 1 WAS produce the highest number of branches at both sites A and B. Early use of urea fertilizer (1 WAS) significantly increased the number of branches relative to 2 and 3 after sowing. The number of branches increased progressively across the weeks.

Table 6: Effects of poultry manure and urea fertilizers on the number of branches of *C. olitorius* plant at both sites.

		4WAS		5WAS		6WAS	
PM (%)	Urea fertilizer (%)/time application (week)	SITE A	SITE B	SITE A	SITE B	SITE A	SITE B
Control		6.22de	4.11fg	9.11cd	5.44de	9.67c	6.78cd
100	0	12.67cd	9.89bc	14.22bc	15.33ab	15.45ab	16.89ab
80	20 @1	14.56ab	10.44ab	16.44ab	13.55cd	16.67ab	16.34bc
	20 @2	11.67de	8.45cd	13.78bc	14.89bc	15.00abc	15.00cd
	20@ 3	10.89de	7.33de	12.22cd	11.89de	13.67abc	13.22bc
60	40 @1	15.11a	11.63a	17.42a	16.55a	18.44a	17.83a
	40@ 2	14.78ab	6.44ef	16.56ab	10.22de	18.22a	12.00cd
	40@3	13.11bc	3.44gh	14.89bc	8.00de	16.56ab	9.33cd
40	60 @ 1	13.67bc	9.89bc	17.00a	14.23cd	16.78ab	15.67bc
	60 @ 2	12.66cd	9.00bc	15.22bc	13.47cd	16.67ab	15.00bc
	60 @ 3	11.33de	7.67de	13.00cd	8.67de	14.22bc	5.33cd
20	80 @ 1	13.11bc	6.33ef	15.00bc	7.78de	16.34ab	8.89cd
	80 @ 2	12.16cd	4.89fg	14.33bc	7.34de	16.00ab	8.78cd
	80 @ 3	7.78cde	2.67hi	9.11cd	6.22de	10.11bc	7.33cd
0	100 @ 1	9.78de	5.11fg	11.55cd	6.22de	13.11bc	7.44cd
	100 @ 2	8.22de	4.00g	10.11cd	5.00de	12.00bc	6.00cd
	100 @ 3	5.33e	1.45i	7.11d	3.67e	8.45c	4.78d

Values followed by similar letters under the same column are not significantly different at

p= 0.05 according to Duncan's multiple range test.

4.1.6. Effect of poultry manure and urea fertilizers on yield parameters of *C. olitorius*

Results of the effects organic and inorganic fertilizers on whole yield, marketable yield and edible yield of *C. olitorius* are presented in Figures 1, 2, and 3 respectively. This shows a significant difference among the treatments and the control at both sites for edible yield (Figure 3).Also, there were no significant differences in all yield parameters between PM alone and urea fertilizer alone applied at either 1, 2 or 3 WAS, however in all, applications of urea fertilizer at week1 WAS of *C.olitorius* showed increase in yield parameters (whole, marketable, edible) more than that of weeks 2 and weeks 3, with values that were not significantly different (Figures 4,5 and 6). In all, 80% PM + 20% urea fertilizer applied at 1 WAS produced significantly higher values of whole yield, marketable yield and edible yield, although this values seems not to be significantly different from that produced by 80% PM + 20% urea applied at 2 WAS and 60%PM + 40% urea applied at 1 WAS. Although in all yield parameters (whole yield, marketable yield and edible yield), 1 WAS had higher values there was no however no significant differences between 1, 2, and 3 WAS.

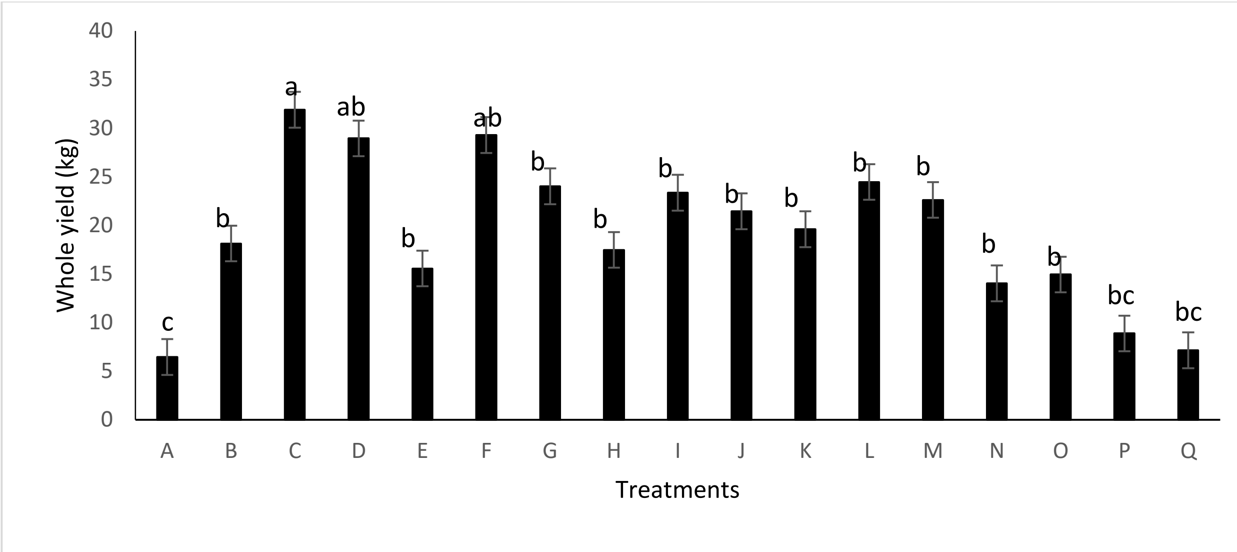

Figure 1: Effects of poultry manure and urea fertilizers on whole yield of *C. olitorius*.

A = control; B= 100% poultry manure (PM); C= 80% PM +20% urea applied @ 1 week after planting (WAP); D= 80% PM + 20% urea applied @ 2 WAP; E= 80% PM + 20% urea applied @ 3 WAP; F= 60% PM + 40% urea applied @ 1 WAP; G = 60% PM + 40% urea applied @ 2 WAP; H = 60% PM + 40% urea applied @ 3 WAP; I=40% PM +60% urea applied @ 1 WAP; J= 40% PM + 60% urea applied @ 2 WAP;K = 40% PM + 60% urea applied @ 3 WAP; L= 20% PM + 80% urea applied @ 1 WAP; M=20% PM + 80% urea applied @ 2 WAP; N= 20% PM + 80% urea applied @ 3 WAP; O=0%PM + 100% urea applied @ 1 WAP; P = 0%PM + 100% urea applied @ 1 WAP; Q = 0%PM + 100% urea applied @ 1 WAP. The vertical bars are showing the standard errors of paired comparisons; bars marked with different letters show means significantly different at 5% level according to Duncan's multiple range test (DMRT).

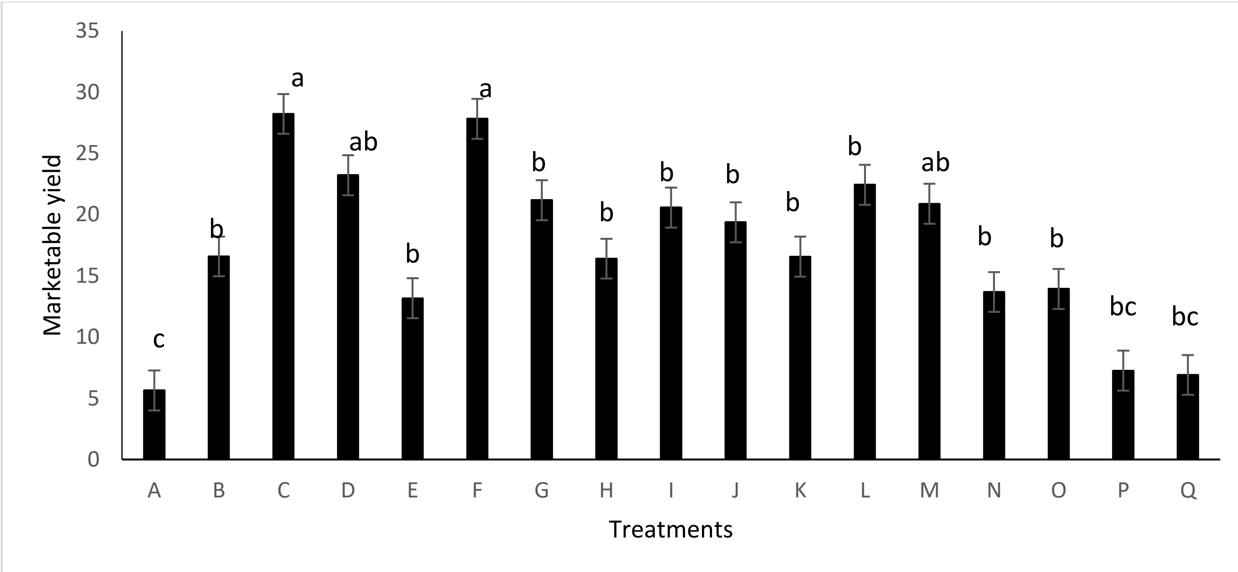

Figure 2: Effects of poultry manure and urea fertilizers on marketable yield of *C. olitorius*.

A = control; B= 100% poultry manure (PM); C= 80% PM +20% urea applied @ 1 week after planting (WAP); D= 80% PM + 20% urea applied @ 2 WAP; E= 80% PM + 20% urea applied @ 3 WAP; F= 60% PM + 40% urea applied @ 1 WAP; G = 60% PM + 40% urea applied @ 2 WAP; H = 60% PM + 40% urea applied @ 3 WAP; I=40% PM +60% urea applied @ 1 WAP; J= 40% PM + 60% urea applied @ 2 WAP; K = 40% PM + 60% urea applied @ 3 WAP; L= 20% PM + 80% urea applied @ 1 WAP; M= 20% PM + 80% urea applied @ 2 WAP; N= 20% PM + 80% urea applied @ 3 WAP; O=0%PM + 100% urea applied @ 1 WAP; P = 0%PM + 100% urea applied @ 1 WAP; Q = 0%PM + 100% urea applied @ 1 WAP.

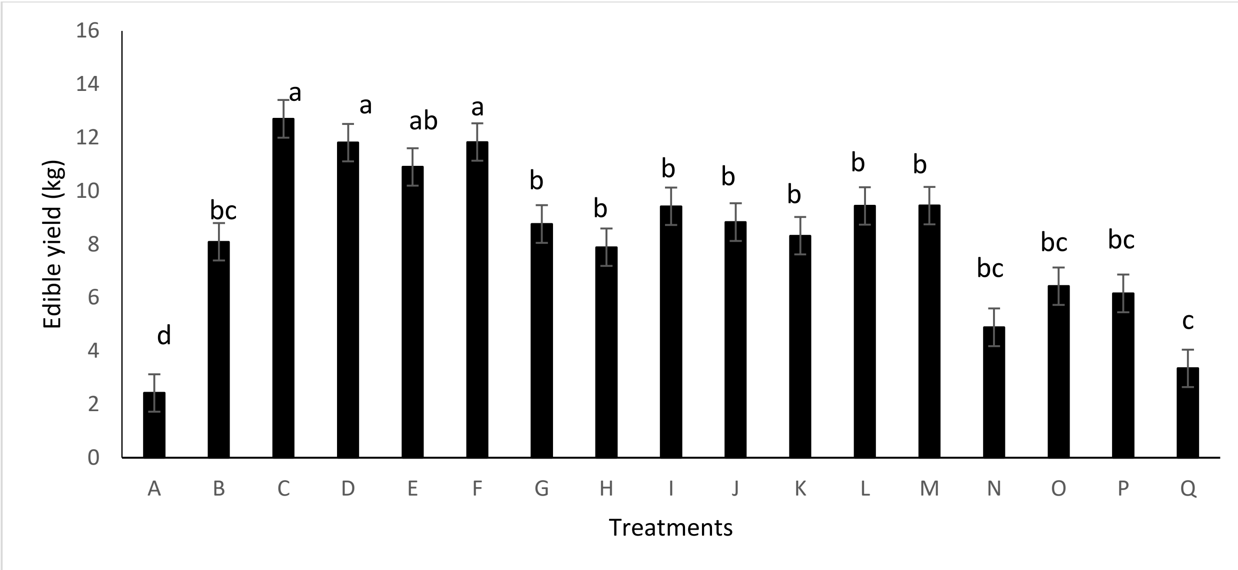

Figure 3: Effects of poultry manure and urea fertilizers on edible yield of *C. olitorius*

A = control; B= 100% poultry manure (PM); C= 80% PM +20% urea applied @ 1 week after planting (WAP); D= 80% PM + 20% urea applied @ 2 WAP; E= 80% PM + 20% urea applied @ 3 WAP; F= 60% PM + 40% urea applied @ 1 WAP; G = 60% PM + 40% urea applied @ 2 WAP; H = 60% PM + 40% urea applied @ 3 WAP; I=40% PM +60% urea applied @ 1 WAP; J= 40% PM + 60% urea applied @ 2 WAP; K = 40% PM + 60% urea applied @ 3 WAP; L= 20% PM + 80% urea applied @ 1 WAP; M= 20% PM + 80% urea applied @ 2 WAP; N= 20% PM + 80% urea applied @ 3 WAP; O=0%PM + 100% urea applied @ 1 WAP; P = 0%PM + 100% urea applied @ 1 WAP; Q = 0%PM + 100% urea applied @ 1 WAP. The vertical bars here shows standard errors of comparisons which was paired; bars using highlighted with different letters shows that the means are significantly different at 5% level according to Duncan's multiple range test (DMRT).

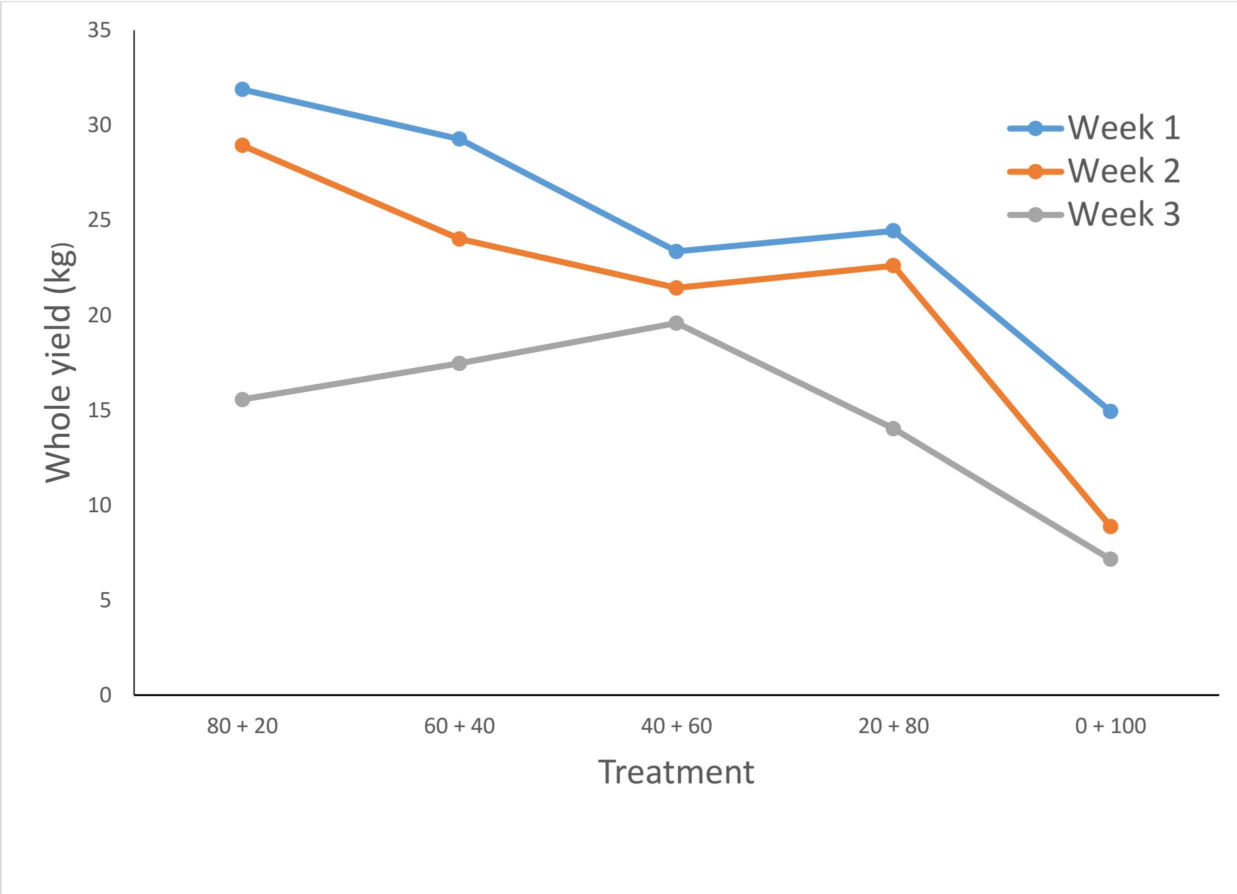

Figure 4: Graphical representation of the effects of inorganic fertilizer (urea) at week 1, 2 and 3 on the whole yield of *C.olitorius*.

A = control; B= 100% poultry manure (PM); C= 80% PM +20% urea applied @ 1 week after planting (WAP); D= 80% PM + 20% urea applied @ 2 WAP; E= 80% PM + 20% urea applied @ 3 WAP; F= 60% PM + 40% urea applied @ 1 WAP; G = 60% PM + 40% urea applied @ 2 WAP; H = 60% PM + 40% urea applied @ 3 WAP; I=40% PM +60% urea applied @ 1 WAP; J= 40% PM + 60% urea applied @ 2 WAP; K = 40% PM + 60% urea applied @ 3 WAP; L= 20% PM + 80% urea applied @ 1 WAP; M= 20% PM + 80% urea applied @ 2 WAP; N= 20% PM + 80% urea applied @ 3 WAP; O=0%PM + 100% urea applied @ 1 WAP; P = 0%PM + 100% urea applied @ 1 WAP; Q = 0%PM + 100% urea applied @ 1 WAP. The vertical bars here shows standard errors of comparisons which was paired; bars using highlighted with different letters shows that the means are significantly different at 5% level according to Duncan's multiple range test (DMRT).

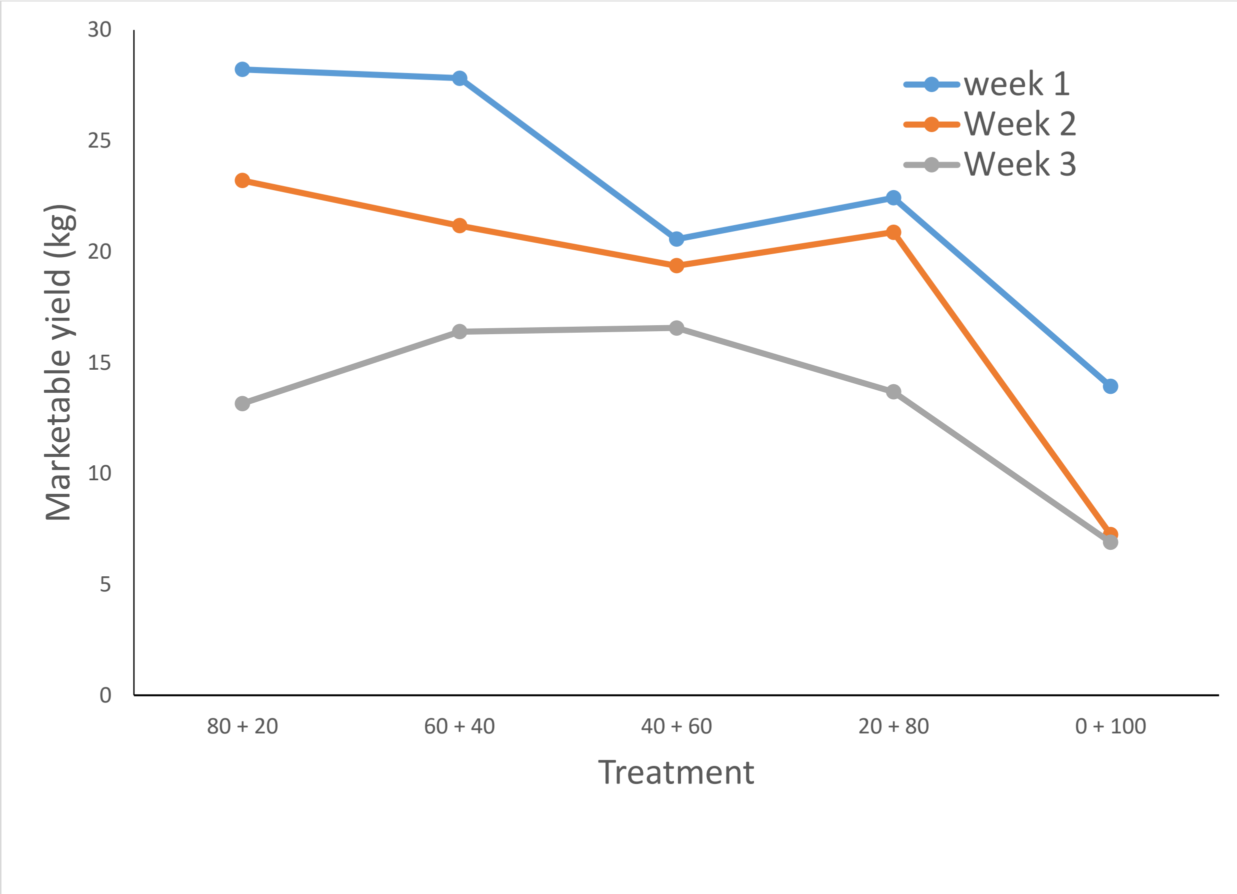

Figure 5: Graphical representation of the effects of inorganic fertilizer (urea) at week 1, 2 and 3 on the on the marketable yield of *C.olitorius.*

A = control; B= 100% poultry manure (PM); C= 80% PM +20% urea applied @ 1 week after planting (WAP); D= 80% PM + 20% urea applied @ 2 WAP; E= 80% PM + 20% urea applied @ 3 WAP; F= 60% PM + 40% urea applied @ 1 WAP; G = 60% PM + 40% urea applied @ 2 WAP; H = 60% PM + 40% urea applied @ 3 WAP; I=40% PM +60% urea applied @ 1 WAP; J= 40% PM + 60% urea applied @ 2 WAP; K = 40% PM + 60% urea applied @ 3 WAP; L= 20% PM + 80% urea applied @ 1 WAP; M= 20% PM + 80% urea applied @ 2 WAP; N= 20% PM + 80% urea applied @ 3 WAP; O=0%PM + 100% urea applied @ 1 WAP; P = 0%PM + 100% urea applied @ 1 WAP; Q = 0%PM + 100% urea applied @ 1 WAP. The vertical bars here shows standard errors of comparisons which was paired; bars using highlighted with different letters shows that the means are significantly different at 5% level according to Duncan's multiple range test (DMRT).

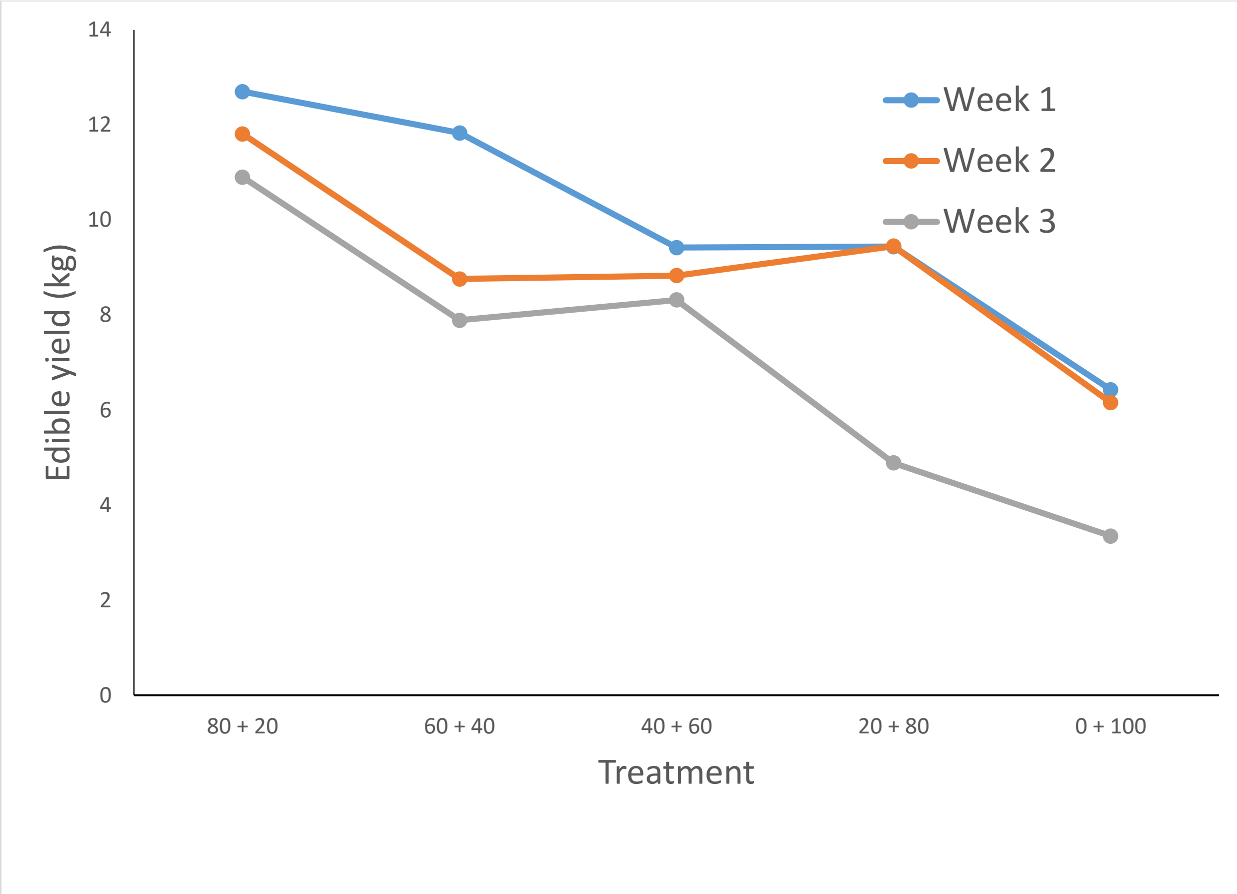

Figure 6:Graphical representation of the effects of inorganic fertilizer (urea) at week 1, 2 and 3 on the edible yield of *C.olitorius.*

A = control; B= 100% poultry manure (PM); C= 80% PM +20% urea applied @ 1 week after planting (WAP); D= 80% PM + 20% urea applied @ 2 WAP; E= 80% PM + 20% urea applied @ 3 WAP; F= 60% PM + 40% urea applied @ 1 WAP; G = 60% PM + 40% urea applied @ 2 WAP; H = 60% PM + 40% urea applied @ 3 WAP; I=40% PM +60% urea applied @ 1 WAP; J= 40% PM + 60% urea applied @ 2 WAP; K = 40% PM + 60% urea applied @ 3 WAP; L= 20% PM + 80% urea applied @ 1 WAP; M= 20% PM + 80% urea applied @ 2 WAP; N= 20% PM + 80% urea applied @ 3 WAP; O=0%PM + 100% urea applied @ 1 WAP; P = 0%PM + 100% urea applied @ 1 WAP; Q = 0%PM + 100% urea applied @ 1 WAP. The vertical bars here shows standard errors of comparisons which was paired; bars using highlighted with different letters shows that the means are significantly different at 5% level according to Duncan's multiple range test (DMRT).

4.1.7. Effect of poultry manure and urea fertilizer application on the Proximate constituents of *C. olitorius*

Table 6 shows the results of the effects of poultry manure and urea fertilizers on proximate content of C. *olitorius*. Application of organic and inorganic fertilizers increased moisture, ash and protein contents of C. *olitorius* relative to the control. Fibre and carbohydrate contents were reduced relative to the control. There were no consistent pattern in case of crude fat between all treatments and the control. Inorganic fertilizer (applied either at 1, 2 or 3 WAS) increased carbohydrate, ash and moisture content of C. *olitiorius* compared with PM. Also, urea (inorganic) fertilizer reduced protein, fibre and fat contents of C. *olitorius* compared with organic manure (PM) alone. There is no significant difference between the times of application of urea fertilizer. Among all treatments, 40% poultry manure and 60% urea fertilizer applied at 2 WAS consistently produced the highest values of moisture content, crude protein and total ash content. It also has the most reduced fat content at site A and site B.

Table 7: Effect of poultry manure and urea fertilizers on proximate content of *C. olitorius*

	Urea ferti-lizer (%)/time application (week)	Moisture content (%)		Crude protein (%)		Total ash (%)		Crude fibre (%)		Crude fat (%)		Carbohydrate (%)	
		Site A	Site B	Site A	Site B	Site A	Site B	Site A	Site B	Site A	Site B	Site A	Site B
Control		6.75	6.31	12.97	12.88	10.31	10.77	9.34	9.85	8.89	7.73	50.67	50.75
100	0	6.78	6.99	17.26	16.94	10.62	12.05	8.38	8.81	9.13	8.45	46.83	45.70
80	20 @1	6.75	7.03	17.05	16.75	10.75	11.93	8.95	9.33	9.09	8.78	47.41	46.14
	20 @2	6.81	7.13	16.97	16.67	11.03	10.98	7.27	7.33	9.12	9.03	48.80	48.86
	20 @ 3	7.02	7.08	16.89	16.72	11.25	11.45	8.08	8.07	8.95	8.44	47.84	48.24
60	40 @1	6.95	7.11	17.00	16.59	11.63	11.52	7.75	7.44	9.02	9.10	47.65	48.24
	40 @ 2	7.07	7.08	16.32	16.30	11.48	12.03	7.28	7.38	8.78	8.89	49.07	47.32
	40@3	7.05	7.15	16.56	16.66	11.05	12.25	7.36	7.54	8.73	8.75	48.25	47.65
40	60 @ 1	7.12	7.18	16.74	16.05	11.60	12.12	7.25	7.37	8.70	8.76	48.59	47.52
	60 @ 2	7.39	7.52	17.33	17.45	11.85	12.26	7.24	7.39	8.65	8.34	48.84	48.64
	60 @ 3	6.84	7.95	17.03	15.89	11.06	11.55	7.17	7.47	9.06	8.48	48.84	49.68
20	80 @ 1	7.13	7.50	16.94	16.67	10.95	11.48	7.33	7.28	9.10	9.05	48.55	48.37
	80 @ 2	7.10	7.10	16.86	16.75	11.04	12.00	7.38	7.55	9.02	8.94	48.60	47.66
	80 @ 3	7.15	7.09	17.04	15.88	11.55	12.15	7.35	7.55	9.06	8.76	47.85	48.57
0	100 @ 1	7.17	7.12	16.65	15.97	11.48	11.67	7.38	7.49	8.89	8.65	48.43	49.15
	100 @ 2	7.20	6.95	16.70	16.79	11.65	11.68	7.36	7.55	8.17	8.07	48.92	49.00
	100 @ 3	7.18	7.03	16.75	16.86	11.67	12.18	7.27	7.63	8.78	8.33	48.35	47.97
	Median	**7.07**	**7.09**	**16.89**	**16.67**	**11.38**	**11.93**	**7.36**	**7.54**	**8.95**	**8.75**	**48.55**	**48.24**
	Mean	**7.19**	**7.09**	**16.66**	**16.34**	**11.30**	**11.87**	**8.42**	**8.62**	**8.89**	**8.62**	**48.44**	**48.20**
	SD±	**0.76**	**0.12**	**0.98**	**0.95**	**0.39**	**0.45**	**1.92**	**0.88**	**0.24**	**0.37**	**0.83**	**1.21**
	CV	**10.57**	**1.69**	**5.88**	**5.81**	**3.45**	**3.79**	**33.87**	**10.21**	**2.70**	**4.29**	**1.71**	**2.51**

4.1.8. Mineral constituents of *C. olitorius* as affected by poultry manure and urea fertilizer

Table 7 shows the results of how poultry manure and urea fertilizers have effect on the mineral contents of *C. olitorius*. Amended treatments increased the potassium, Ca, Mg and P contents of C. *olitorius* relative to the control. K and P contents of C. *olitorius* was not increased by urea fertilizer alone applied at 1, 2 and 3. The values of potassium for amended soils for site A was not significantly different in relative to control. All amended soil increased N content of C. *olitorius* relative to the control. Organic manure (PM) increased K, Ca, Mg and P contents of C. *olitorius* relative to the urea fertilizer alone applied at 1, 2 or 3 WAS. Organic manure (PM) increased N contents of C. *olitorius* relative to the urea fertilizer alone applied at 1, 2 or 3 WAS at site A, there was no significant differences between organic and inorganic fertilizers for site B. In all, 40% poultry manure and 60% urea fertilizer applied at 2 WAS has the best values of K, Ca, Mg N and P contents.

Table 8: Effect of poultry and urea fertilizers on mineral contents of *C. olitorius*

PM (%)	Urea ferti-lizer (%)/time application (week)	K (ppm)		Ca (ppm)		Mg (ppm)		N (ppm)		P (ppm)	
		Site A	Site B	Site A	Site B	Site A	Site B	Site A	Site B	Site A	Site
Control		1031.25	1030.25	1.3	1.29	0.65	0.20	1.14	1.04	680.71	143.16
100	0	1281.25	1312.50	1.70	1.60	1.30	0.20	1.68	1.74	962.54	1539.34
80	20 @1	1230.00	1218.75	1.55	1.65	2.10	0.60	1.63	1.77	863.49	1155.34
	20 @2	1233.33	1343.75	1.70	1.95	2.50	1.15	1.74	1.92	944.53	1140.82
	20 @ 3	1093.75	1125.00	1.55	1.45	1.40	1.15	1.89	2.03	938.23	1100.68
60	40 @1	1234.25	1281.25	1.40	1.90	0.25	0.70	1.42	2.20	1084.99	806.77
	40 @ 2	1088.00	1285.25	1.70	1.95	1.40	0.45	1.42	2.28	835.58	685.22
	40@3	1031.25	1285.25	1.45	1.90	2.10	0.15	1.57	2.78	1030.07	902.22
40	60 @ 1	1156.25	1250.00	1.70	1.70	0.90	0.50	1.79	1.93	840.99	591.57
	60 @ 2	1156.00	1318.75	1.80	1.95	0.95	1.85	2.31	2.78	1796.56	1900.41
	60 @ 3	1126.25	1212.50	1.65	1.95	0.95	0.30	1.62	1.78	915.72	759.95
20	80 @ 1	1108.75	1156.25	2.05	1.80	0.95	1.20	2.20	1.73	1168.74	820.73
	80 @ 2	1031.25	1187.50	1.80	1.20	0.85	1.80	1.84	1.76	970.65	845.49
	80 @ 3	1062.5	1093.75	1.55	1.20	0.75	1.15	1.86	1.56	971.55	843.69
0	100 @ 1	1062.5	1031.25	1.41	1.70	0.50	1.50	1.59	1.73	517.74	162.43
	100 @ 2	1093.75	1093.25	1.50	1.90	0.75	1.55	1.56	1.78	776.16	928.33
	100 @ 3	1031.25	1030.25	1.30	1.90	0.50	1.50	1.57	1.73	733.78	598.76
	Median	**1062.50**	**1218.75**	**1.65**	**1.70**	**0.95**	**0.85**	**1.74**	**1.77**	**915.72**	**806.77**
	Mean	**1015.62**	**1191.50**	**1.629**	**1.62**	**1.15**	**0.93**	**1.76**	**1.87**	**890.12**	**707.30**
	SD ±	**277.3**	**107.69**	**0.21**	**0.31**	**0.63**	**0.62**	**0.34**	**0.32**	**152.68**	**273.84**
	CV	**27.30**	**9.038**	**12.89**	**19.13**	**54.78**	**66.67**	**22.72**	**17.11**	**17.15**	**38.72**

4.2. DISCUSSIONS

4.2.1. Poultry manure and urea fertilizers effects on growth and yield parameters of *C. olitorius*

The stem girth, number of branches, plant height, number of leaves, whole yield, marketable yield and edible yield increased significantly (p = 0.05) across all the treatments compared to the control at both sites. This was due to the soil amendments which was PM and urea fertilizer that both contains nitrogen as one of the main nutrients that is needed by plant for growth which have been released into the soil for plant uptake (Adekiya et al., 2019). According to Castellanos, Uvalle-Bueno and Aguilar-Santelises (2000) N is the major yield and growth components and a distinctive ingredient of functioning plasma. It is found in chlorophyll molecules, proteins, amino acids, nucleic acids (RNA and DNA), nucleotides, phosphotides, alkaloids, enzymes, coenzymes, hormones, and vitamins. This also revealed that the experimental soil was deficient in nutrient according to Table 1.Increase in vegetative growth of *C. olitorius* due to urea fertilizer could be ascribed to increased uptake of nitrogen from the soil from applied urea fertilizer which is in association of with its role in chlorophyll synthesis and thus the process of photosynthesis and carbon dioxide assimilation (Jasso-chaverria, Hochmuth, Hochmuth and Sargent, 2005) leading to improved growth. This has proved that nitrogen stimulates formation of new leaves and increases plant height. Tovihoudji et al. (2015) also reported that urea fertilizer improved C. *olitorius* growth. Emuh (2013) and Adenawoola and Adejoro (2005) also found that growth of C. *olitorius* improved with the application of PM

The poultry manure alone at 100% improves the stem girth, leaf numbers, number of branches and plant height in compared to urea fertilizer alone (100%) either at 1, 2 or 3 WAS at both sites. This could be ascribed to high content of nutrients (both macro nutrients and micro nutrients) in the poultry manure and also due to its low C: N ratio (7.38), leading to faster decomposition and subsequent release of nutrient most especially nitrogen which leafy vegetable like *C. olitorius* needs. N has been known to increase leaf sizes, promote rapid growth as well as above ground vegetative growth. Apart from increasing soil nutrients, PM may also improve soil structure (Adekiya et al., 2020). The lower growth of *C. olitorius* due to urea fertilizer alone relative to PM could be attributed to the fact that urea fertilizer is prone to losses by run-off, volatilization, leaching and/or denitrification. Mobile nutrient like N is highly soluble and is not adsorbed on clay complex especially in coarse-textured soils high in the sand (68%) as in the case of the study sites. In such soils, loss of N by leaching will be very high coupled with the high rainfall of the area. These results are in agreement with that of Mogapi et al. (2013) on the effect of poultry manure and commercial fertilizer on growth of *C.olitorius*.

Integration of organic (PM) and inorganic (Urea) fertilizers increased the growth and yield of *C.olitorius* compared to their sole forms. This could be attributed to reduced nutrient loss through leaching by the combination which led to increased nutrient use efficiency following the inclusion of the N fertilizer with poultry manure (Abbasi, Khaliq. Shafiq, Kazmi and Ali 2010; Souri, Rashidi and Kianmehr. 2018). Therefore, it was resolved that urea fertilizer added to PM assisted in mineralization of both micro and macro nutrients in poultry manure due to improved supply of nutrients that leads to better growth and yield. Okokoh and Bisong (2011) reported that PM combined with Urea-N had a better effect on *Amaranthus cruentus* growth than either Urea-N or poultry manure alone.

Treatment 60% PM + 40% urea fertilizer applied at 1 WAS produced significantly higher values of growth and yield parameters of *C.olitorius.* This could be attributed to reduced nutrient loss through leaching by urea fertilizer as a result of the combination and maximal nutritional availability by PM at 80 % which was ascribed to the increase organic matter composition of the poultry manure.

Urea fertilizer application at 1 WAS has best growth and yield in this experiment. This could be ascribed to the synchrony in the time of availability of adequate amount of N (nutrient) from urea fertilizer present in the soil to the need by the *C. olitorius* plant for absorption and usage. Consequently, application of urea (N) fertilizer to *C. olitorius* especially 3 WAS is possibly a waste as the *C. olitorius* plant, that stage of growth, as a short-duration crop does not have the capacity to use the nutrients in any significant amount at this stage of its growth.

4.2.2. Effects of poultry manure and ureac fertilizer on proximate content of C. *olitorius*.

Results that application of organic and inorganic fertilizers increased moisture and protein contents of C. *olitorius* relative to the control might be as a result of increase in the supply of nutrients due tourea fertilizer and PM applications. The amendments application improved N supply to the soil and subsequently absorbed by the C. *olitorius* plant and hence increased number of leaves and photosynthetic activity and enhancing physiological processes leading to the production of more assimilates which leads to increase in chemical composition of the C. *olitorius* leaf (Adekiya et al., 2019). Moisture and protein in the C. *olitorius* plant increased because of the improved soil N due to the application of PM and urea fertilizer. While N encouraged better vegetative growth, development and growth of roots thereby boosting greater absorption of water, it also improved the protein composition of C. *olitorius*, amino acids, which are the building blocks of protein, and enzymes, which catalyze the majority of biochemical activities, are all recognized to be essential components in plants (Brady and Weil, 2008).The ash content was a bit high probably due to a more balanced nutrient in the amended soils relative to the control that has lower nutrient contents. Higher values of carbohydrate are gotten in control plot relative to amended soils also corroborates the findings of Adekayode (2004). PM increased protein, fibre and fat contents of C. *olitorius* relative to urea fertilizer alone; this can be said to be the differences in the chemical component of urea fertilizers as compared to PM.

Inorganic fertilizer (applied either at 1, 2 or 3 WAS) increased carbohydrate, ash and moisture content of C. *olitiorius* compared with PM this can said to be due to the additional nitrogen nutrient present in the urea fertilizer that promotes the quality of plant, rapid release of the nutrients for plant consumption, PM releases nutrients only when the soil is warm and moist, which correlates with C. *olitorius* times of need, and they rely on soil organisms to break down organic matter, thus nutrients are released more slowly than inorganic fertilizers, but it takes time to give nutrients to plants. Urea fertilizers, on the other hand, give these nutrients in a more readily available form in the soil for immediate use. The application of inorganic fertilizer alone plots. Mishra and Ganesh (2005) had previously documented these tendencies in their study of how various fertilizers impact nutritional status.

4.2.3. Effect of poultry manure and urea fertilizers on mineral contents of *C. olitorius*

Results showed that amended treatments improved the potassium, Calcium, Magnesium and Phosphorus contents of C. *olitorius* relative to the control no (amendment). This can be said to be as a result of more nutrients availability in the soil from the integrated use of organic manure (PM) and inorganic fertilizer (urea) that brought about the increase in uptake by C. *olitorius* plant. Organic manure (PM) increased K, Ca, Mg and P contents of C. *olitorius* relative to the urea fertilizer alone applied at 1, 2 or 3 WAS. This could be related to the chemical components of NPK versus PM fertilizer, as well as its beneficial effect on soil ecology and plant metabolism according to Hassan, Othman and Siriphanich (2012). For example, urea fertilizers contain only N, whereas PM contains micro and macronutrients. The amount and quality of nutrients taken by the plant is influenced by the minerals (mineral nutrients) present in the amendment used and therefore in the soil. The improved mineral contents of C. *olitorius* under integrated PM and urea fertilizer was as a result of increased soil nutrient due to PM addition to urea fertilizer which leads to increase in greater metabolic activities and therefore minerals higher in the integrated plots relative to their single forms.

CHAPTER FIVE

Conclusion and Recommendation

The results from this experiment revealed that urea fertilizer and PM (sole or combined) increased growth (numbers of leaf, plant height, number of branches and stem diameter), yield (whole yield, marketable yield and edible yield) parameters, proximate and mineral contents of C. *olitorius* relative to the control. PM increased these parameters relative to urea fertilizer applied either at 1, 2, or 3 WAS. Altogether, there wasn't really any significant differences in applying urea fertilizer to C. *olitorius* at 1, 2 and 3 WAS. 60% PM + 40% urea fertilizer applied at 1 WAS produced the best growth and yield parameters. This was ascribed to the synchrony in the time of availability of adequate amount of N (nutrient) from urea fertilizer present in the soil to the requirement of the *C. olitorius* plant for absorption. In all, 40% poultry manure and 60% urea fertilizer applied at 2 WAS has the best values of proximate and mineral contents of C. *olitorius*.

Therefore, for those that desire to cultivate C. *olitorius* for its edible leaves, application of 60% PM + 40% urea fertilizer applied at 1 WAS is recommended. However, for those that want the quality of the C. *olitorius* leaves, 40% poultry manure and 60% urea fertilizer applied at 2 WAS is recommended.

6.0. REFERENCES

Abbasi M. K.,. Khaliq A, Shafiq M., Kazmi M, and Ali I., (2010) Comparative effectiveness of urea , poultry manure and their combination in changing soil properties and maize productivity under rainfed conditions in northeast Pakistan, Experimental Agriculture, vol. 46, no. 2, pp. 211–230,.

Abbasi, K.M., Mahmood T.M., Sabir N and Khurshid M. (2015). Impact of the addition of different plant residues on nitrogen mineralization–immobilization turnover and carbon content of a soil incubated under laboratory conditions. *Solid Earth*, *6*(1), 197-205.

Adediran, O.A., Ibrahim, H., Tolorunse, K.D. and Gana, U.I. (2015). Growth, Yield and Quality of Jute Mallow *(Corchorus olitorius* L.) as Affected by Different Nutrient Sources. International Journal of Agriculture Innovations and Research, 3(5):1443-1446.

Adekayode, F. O. (2004). The use of manure to increase the yield and quality of *Amaranthus* to feed rabbit in a humid tropical region. *Journal of Animal and Veterinary Advances 3 (11): 758 – 762.*

Adekiya A.O, Agbede T.M, Aboyeji C.M, Adegbite, K.A, Dunsin O, Adekanye T.A, Aremu C. O (2019). Soil properties, okra performance and nutrient compositions as affected by tillage and maize cob ash. J. Crop Sci. Biotech. 22 (2): 113 – 122.

Adekiya, A. O. and Agbede, T. M. (2009). Growth and yield of tomato (*Lycopersicon esculentum* Mill) as influenced by poultry manure and NPK fertilizer. *Emirates Journal of Food and Agriculture*, 21 (1): 10-20

Adekiya, A. O., Agbede, T. M., Aboyeji, C. M., Dunsin, O. and Ugbe, J. O. (2019) Green manures and NPK fertilizer effects on soil properties, growth, yield, mineral and vitamin C composition of okra (*Abelmoschus esculentus* L.).*Journal of Saudi Society of Agricultural Science, 18: 218 - 223*

Adekiya, A. O., Ogunboye, O. I., Ewulo, B. S., and Olayanju, A. (2020). Effects of Different Rates of Poultry Manure and Split Applications of Urea Fertilizer on Soil Chemical Properties, Growth, and Yield of Maize. *The Scientific World Journal*,Volume 2020, Article ID 9391630, 9 pages. https://doi.org/10.1155/2020/9391630 *2020.*

Adenawoola AR, Adejoro SA. (2005). Residual effects of poultry manure and NPK fertilizer residues on soil nutrient and performance of Jute (*Corchorus oliferious* L.). *Nigerian Journal of Soil Science.15: 133-135.*

Agbede T.M. Adekiya A.O., Ale M.O, Eifediyi E. K and Olatunji C. A(2019). Effects of Greenmanuresand NPK fertilizeronsoil properties, tomato yield and quality in the forest-savanna ecology of Nigeria .Expl Agric., *volume 55 (5), pp. 793–806. doi:10.1017/s0014479718000376*

Agbede, O. O. (2009). Understanding Soil and Plant Nutrition, Petra Digital Press, Abuja, 2009

Akinrinde, E. A., Obigbesan,G. O. (2000). Evaluation of the fertility status of selected soils for crop production in five ecological zones of Nigeria. Proceedings 26th Annual Conference ofSoil Science Society of Nigeria, Ibadan,Nigeria. pp. 279288.

Aluko, O.A., Olanipekun, T.O., Olasoji, J.O., Abiola, I.O., Adeniyan, O.N.,Olanipekun, S.O., Omenna, E.C., Kareem, K.O. and Douglas, A.I. (2014). Effect of Organic and Inorganic Fertilizers on the yield and Nutrient composition of Jute Mallow.Global Journal of Agricultural Research2 (3): 1-9.

Ayeni, M.J . Oye, O.V. (2017) Effect of Different Organic Fertilizers on the Growth Performance of *Corchorus olitorius* L.*Journal of Agriculture and Veterinary Science 10, (4) Ver. II,:38-44*

Ayinla, A., Alagbe, I. A., Olayinka, B. U., Lawal, A. R., Aboyeji, O. O., and Etejere, E. O. (2018). Effects of organic, inorganic and organo-mineral fertilizer on the growth, yield and nutrient composition of *Corchorus Olitorious (L)*. *Ceylon Journal of Science*, *47*(1), 13–19.

Castellanos, J.Z., Uvalle-Bueno, J.X., and Aguilar-Santelises, Y.A. (2000). Manual de interpretacion de analisis de suelos, aguas agricolas, plantas y ECP. 2nd ed. INIFAP, Chapingo, Mexico.

Emuh F. N., 2013. Growth and yield performance of *Corchorus olitorious L*. influenced by levels of poultry manure in Niger-Delta, Nigeria. African Journal of Biotechnology, 12(19): 2575-2580.

Frank, K., Beegle, D., Denning, J., 1998. Phosphorus. In: Brown, J.R. (Ed.), Recommended Chemical Soil Test Procedures for the North Central Region, North Central Regional

Research Publication No. 221 (Revised). Missouri Agric. Exp. Station, Columbia(MO), pp. 21–26.

Garjila, Y. A., Shiyam, J. O., and Augustine, Y. (2017). Response of Jew's Mallow (*Corchorus olitorius* L.) to Organic Manures in the Southern Guinea Savanna Agroecological Zone of Nigeria. *Asian Research Journal of Agriculture*,1-6, DOI: 10.9734/ARJA/2017/31265

Ghazi, D. (2018). Effect of Nitrogen Fertilization and Foliar Application with Iron Plus Molybdenum on Quality Parameters and Chemical Composition of Jews Mallow Plant (*Corchorus olitorius* L.). *Journal of Soil Sciences and Agricultural Engineering*, *9*(6), 243-251.

Grubben, G. J. H., and Denton, O. A. (2004). Plant resources of tropical Africa 2. Vegetables. *Plant resources of tropical Africa 2. Vegetables.*

Harborne J.B., Baxter H and Moss G.P., (1999). Phytochemical Dictionary: A Handbook of Bioactive Compounds from Plants, 2nd edition, Taylor and Francis, Philadelphia, USA.

Hendershot, W.H., Lalande, H., Duquette, M., 2007. Ion exchange and exchangeable cations. Soil sampling and methods of analysis. In: Carter, M.R., Gregorich, E.G (Eds.), Canadian Society of Soil Science, 2nd ed. CRC Press, Boca Raton (Florida), pp. 197–206 Chapter 18.

Hassan, A., Othman, Z., and Siriphanich, J. (2011). Pineapple (Ananas comosus L. Merr.). In *Postharvest biology and technology of tropical and subtropical fruits* (pp. 194-218e). Woodhead Publishing.

Islam, T. M. (2013). A Comprehensive Review of *Corchorus Capsularis*: A Source of Nutrition, Essential Phytoconstituents and Biological Activities. Journal of Biomedical and Pharmaceutical Research. 2 (1): 01-08.

Jasso-Chaverria C., Hochmuth G.J., Hochmuth R.C., and Sargent S.A., (2005). Fruit yield, size, and colour responses of two Greenhouse cucumber types to nitrogen fertilization in perlite soilless culture. Horticulture Technology, 15 (3): 565-571.

Kar, C. S., Kundu, A ., Sarkar, D., Sinha, M. K., and Mahapatra, B. S. (2009). Genetic diversity in jute (Corchorus spp) and its utilization: a review. Indian Journal of Agricultural Sciences,79 (8):575-86 2009

Katé, S., Tovihoudji, P. G., Batamoussi-Hermann, M., Sossa, E. L., Idohou, R., Agbangba, E. C., and Sinsin, B. (2020). Growth, Yield and Nutrient Use Efficiency of Corchorus olitorius under Irrigated and Rain-fed Conditions in Northeastern Benin (West Africa). *Asian Journal of Agricultural and Horticultural Research*, 32-44

Khan, M. S., Shil, N. C., and Noor, S. (2008). Integrated nutrient management for sustainable yield of major vegetable crops in Bangladesh. *Bangladesh Journal of Agriculture and Environment*, *4*(5), 81-94.

Makinde S., M. Imisu Usilo, E. Adeyinka Makinde and L. Samuel Ayeni (2011) Comparative effect of mineral fertilizers and organic manures on growth, nutrient content and yield of *Corchorus olitorus*and *Celosia argentea*. Research Journal of Botany.Volume: 6- Issue:4-150-156DOI: 10.3923/rjb.2011.150.156

Mani D, Upadhyay K. S, Kumar C., Balak S., and Pathak N.(2011) Effect of integrated nutrient management in Maize (*Zea mays* L), New Agriculturist, vol. 22, no. 1, pp. 5–14.

McRoberts, K. (2015). On-farm forage fertilization and cattle manure value chain characterization in Vietnam, low-infrastructure fiber technique, and image analysis for *alfalfa*

Mishra, R.K. and Ganesh, S. (2005). Effect of sources of nutrients on performance of okra (*Abelmoschus esculentus L. Moench*) Sri Lankan Journal of Agricultural Sciences, 42:52-57

Mogapi E.M., Mathowa T., Mpofu, C., Stephen, N. and Machacha, S. (2013). Effect of chicken manure and commercial fertilizer on performance of jute mallow (C*orchorus olitorius*). Agriculture and Biology Journal of North America. 2151-7517, ISSN Online: 2151-7525, doi:10.5251/4.6.617.622

Naim, A. H., Ahmed, K. M., Ahmed F. E. (2015) Effects of chicken manure on growth and yield of Jute Mallow (*Corchorus olitorius* L.) under Rain-Fed Conditions of Sudan. *Open Access Library Journal*, *2*: e2042. http://dx.doi.org/10.4236/oalib.1102042

Nelson, D.W., Sommers, L.E., 1996. Total carbon, organic carbon and organic matter. In: Sparks, D.L. (Ed.), Methods of Soil Analysis. Part 3, 2nd ed. ASA and SSSA, Madison (WI), pp. 961–1010 SSSA Book Series No. 5.

Okokoh, S. J., Bisong, B. W. 2011. Effect of poultry manure and urea-N on flowering occurrence and leaf productivity of *Amaranthus cruentus*. Journal of Applied and Environmental Science Management.15(1): 13-15. DOI: 10.4314/jasem.v15i1.65667

Okunlola, S. A. Adejoro, and G. Fakanlu, (2011) Evaluation of Some Manure Types for the Growth and Yield of Watermelon in Southwestern Nigeria. Researcher. 3(3):61-66]. (ISSN: 1553-9865). http://www.sciencepub.net.

Olaniyi J. O, Ajibola A. T. (2008) Growth and yield performance of *Corchorus olitorius* varieties as affected by nitrogen and phosphorus fertilizers application.American-Eurasian Journal of Sustainable Agriculture, 2(3): 234-241

Sanni, K.O., J.M. Adesina, B.S. Ewulo, S.O. Ojeniyi and F.E. Mazi, (2013). Comparative effect of variable rates of pig and poultry manure on the agronomic performance of *Amarathushybridus* in humid rainfall southwestern Nigeria. Nig. J. Soil Sci., 23: 42–47

Schrippers, R. R. (2000). African indigenous vegetables. An overview of the cultivated species. U.K. S National Resources Institute. Technical Report. Chatam.

Souri M. K., Rashidi M., and Kianmehr M. H., "Effects of manure-based urea pellets on growth, yield, and nitrate content in coriander, garden cress, and parsley plants," Journal of Plant Nutrition, vol. 41, no. 11, pp. 1405–1413, 2018.

Tovihoudji, G. P., Djogbenou, C. P., Akponikpe, P. B. I., Kpadonou, E., Agbangba, C. E., and Dagbenonbakin, D. G. (2015). Response of Jute Mallow (*Corchorus olitorius* L.) to organic manure and inorganic fertilizer on a ferruginous soil in North-eastern Benin. JournalofAppliedBiosciences,92,86108619.dx.doi.org-10.4314-jab.v92610 –ISSN 1997–5902

Uwah, D. F., and Iwo, G. A. (2011). Effectiveness of organic mulch on the productivity of maize (*Zea mays* L.) and weed growth. *The Journal of Animal & Plant Sciences*, *21*(3), 525-530.

Walkley, A.J.,*Black*, I.A., *1934*. Estimation of soil organic carbon by the chromic acid titration method. Soil Sci. 37, 29-38.

REP 1			REP 2			REP 3		
A1	A11	A7	B1	B2	B9	C1	C1O	C17
A15	A9	A2	B13	B17	B11	C14	C11	C4
A13	A16	A10	B8	B10	B4	C8	C9	C6
A6	A8	A3	B5	B6	B3	C15	C12	C7
A14	A12	A5	B16	B12	B15	C13	C3	C2
A17	A4		B7	B14		C16	C16	

Experimental Layout