Effect of biofertilizer produced from cow dung and conventional fertilizer on Plant Growth

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***Abstarct*— *This experimental research work is on the production of biofertilizer from cow dung and the comparism of plant growth rate using biofertilizer and chemical fertilizer. It was conducted first with anaerobically degeneration of cow dung in a minifloating biodigester for a period of 30 days to produce biofertilizer, a liquid with soil enriching property hence suitable for plant growth, then test of the effect on growth rate using the biofertilizer and chemical fertilizer on cultivated maize in nurseries for a period of 30 days. Laboratory test of biofertilizer recorded pH of 4.9, N_2 of 0.026mg/l, K of 650mg/l, while chemical fertilizer had pH of 5.1, N_2 of 0.00124mg/l, K of 3416.66mg/l. Test results based on performance of the fertilizers on the growth rate of maize shows the height of stem for the biofertilizer and chemical fertilizer to be 26.2cm and 25.3cm respectively, the length of roots to be 11.4cm and 10.3cm for the biofertilizer and chemical fertilizer respectively, and the length of the broadest leaf to be 25.8cm and 25.2cm for the biofertilizer and chemical fertilizer respectively.The results from all the resaerch shows that cow dung can be converted through, anaerobic biodegradation to biofertilizer amongst other useful products and the biofertilizer produced is richer in nutrints than the chemical fertilizer, hence it is more suitable and have a better effect on growth rate.*

***Keyword*— Biofertilizer, Chemical fertilizer, Plant growth rate.**

I. INTRODUCTION

To the uneducated man, to fertilize means to improve fertility or production of a substance and this can stand even in the education sector as the simplest definition of a fertilizer. Before we talk about this, we would first want to know what a soil is because that is what we would be trying to improve. The soil is a natural body of finely divided rocks, minerals and organic matter. The sand, silt, clay and organic matter in the soil helps provide tilth, necessary aeration and favorable water intake rates but they rarely maintain adequate plant food to sustain continuous healthy plant growth – this is why we fertilizer it.

Management of soil fertility has been the preoccupation of farmers for thousands of years. Egyptians, Romans, Babylonians, and early Germans are all recorded as using minerals and or manure to enhance the productivity of their farms *(Heinrich, 2000).*The modern science of plant nutrition started in the 19th century and the work of German chemist Jutus Von Lieberg, among others. John Bennet Lawes, an English entertainment, began to experiment on the effects of various manures on plants growing in pots in 1837, and a year or two later the experiments were extended to crops in the field. One immediate consequence was that in 1842 he patented a manure formed by treating phosphates with sulfuric acid, and thus was the first to create the artificial manure industry. In the succeeding year he enlisted the services of Joseph Henry Gilbert, with whom he carried on for more than half a century on experiments in raising crops at the institute of arable crops Research *(Chisholm, 1911).*

Fertilizer refers to any compound that contains one or more chemical elements, organic or inorganic, synthetic or natural, that is placed on or incorporated into the soil or applied to directly onto plants to achieve growth (McKenzie, 1998). Proper nutrition is essential for satisfactory crop growth and production. Some of such nutrients includes carbon, hydrogen, oxygen, nitrogen, phosphorus, potassium, sulphur, calcium, magnesium, boron, chlorine, copper, iron, manganese, molybdenum and zinc. The profit potential for farmers depends on producing enough crop per acre to keep production cost below the selling price – therefore a need for productivity to increased is paramount and this gives rise to the need for a fertilizer (Mackenzie, 1998). Almost all biological wastes can be used to fertilize the soil, when used they are referred to as manures.

Manure can be said to be a mixture of animal faeces, urine, livestock bedding, additional water and wasted feed. Factors like the livestock type, stage of growth and feeding practices (all of which determine nutrient excretion rates) as well as the amount of bedding or water added to the manure, type of manure storage, time that the manure spends in storage and weather conditions affect nutrient composition of manure. Cow dung falls under this category of soil enrichers but however the use of cow dung like almost all other untreated manures are harmful in the long run, as they provide both the elements the plant needs for growth and elements that are harmful to the soil and plant growing on it.

The need for other methods to provide soil nutrients gave birth to fertilizers. There are two main types of fertilizers; chemical fertilizer and biofertilizer. Chemical fertilizers are defined as any inorganic material of wholly or partially synthetic origin that is added to the soil to sustain plant growth while biofertilizers are substances which contains living microorganisms with the ability to colonize the rhizosphere or the interior of the plant and promote growth by increasing the supply or availability of primary nutrients to the host when applied to seeds, plant surface or soil.

General, the chemical fertilizer is more readily available and would be the best option for soil enrichment but a lot of artificial fertilizers contain acids, such as sulfuric acid and hydrochloric acid, which tend to increase the acidity of the soil, reduce the soil's beneficial organism population and interfere with plant growth. Chemical fertilizers may also affect plant health. For example, citrus trees tend to yield fruits that are Generally, healthy soil contains enough nitrogen-fixing bacteria to fix sufficient atmospheric nitrogen to supply the needs of growing plants lower in vitamin C when treated with high nitrogen fertilizer.

On the other hand, organic fertilizer (biofertilizer) adds nutrients to soil, increases soil organic matter, improves soil structure and tilth, improves water holding capacity, reduces soil crusting problems, reduces erosion from wind and water, improves water holding capacity and improves buffering capacity against fluctuations in pH levels. Bio-fertilizer is a dark brown in color whether in its solid or liquid state, it is made from biodegradable organic matter, vegetable waste, etc., through microbial conversion process. It is free from foul smell, live weed seeds, plastics, glass, and also free as a source for spreading pests and diseases. Its moisture content is about 25% with a bulk density of 0.64 gm / c.c. (*Shovon et al, 2013*).

Bio-fertilizers such as Rhizobium, Azotobacter, Azospirillum and blue green algae have been in use a long time ago. The knowledge of applied microbial inoculum is a long history which passes from generation to generation of farmers. It started with culture of small-scale compost production that has evidently proved the ability of bio-fertilizer (Khosro and Yousef, 2012).

This is recognized when the culture accelerates the decomposition of organic residues and agricultural byproducts through various processes and gives healthy harvest of crops (Abdul-Halim, 2009). The commercial history of bio-fertilizer began with the launch of "Nitragin" by Nobbe and Hilther in 1895. This was followed by the discovery of Azotobacter and then Blue-green algae and a host of other microorganisms which are being used till date as bio-fertilizer (Kribacho, 2010).

Manure can always be converted to biofertilizer, a process during which microbes break down the feed (manure) removing excess of unwanted elements and leaving the essential microbes and elements. The production of bio-fertilizer involves 3 biochemical steps which include the breaking down of complex materials into simpler substances in a process known as anaerobic digestion. Anaerobic bio-digestion is a process whereby microorganisms' breakdown biodegradable materials in the absence of oxygen (Ezigbo, 2005). This process generates a product called biogas that is primarily composed of methane, carbon dioxide and the bio-fertilizer suitable as soil conditioners (Owamah *et al*, 2014).

Cow dung one of the organic wastes that can be converted to biofertilizer is the waste product of bovine animal species (cow, buffalo, yak, etc.). It can also be said to be the undigested residue of plant matter which has passed through the animal's gut. When cow dung is decomposed, it has been experimentally proven that its slurry is composed of 1.8-2.4% nitrogen, 1.0-1.2% phosphorus, 0.6 - 0.8% potassium and 50-75% organic humus (*Shovon et al, 2013*).The moisture content (wet basis) was measured by drying at 105ºC for approximately 24 hours. For the water holding capacity, a wet sample of known initial moisture content was weighed (Wi) and placed in a beaker. After soaking in water for 1–2 days and draining excess water through 2 filter papers, the saturated sample was weighed again. The amount of water retained by dry sample was calculated as the WHC. Bulk density was measured using an approximately 10 liters' volume container. The container was filled with material, and then the material was slightly compacted to ensure absence of large void spaces. The bulk density was calculated by dividing the weight of the material by the volume of material in the container (*Shovon et al, 2013*).

II. METHODOLOGY

The biodigester used for this process is a mini floating biodigester which was locally made from;

1. plastic drums
2. pipes
3. tap heads
4. gum and other fittings.

Two drums of different sizes were employed for the preparation of the biodigester, the larger drum was 220 liters in volume and this was where the cow dung was loaded after mixing with water, the smaller drum also known as the gas holder, its volume was 180 liters. The gas holder severed two purposes; as a cover to avoid air penetration (facilitating anaerobic fermentation) and also as a trap for the biogas (the gaseous emission from the anaerobic degeneration of an organic matter be it plant or animal) that was going to be produced by this process, a gas outlet was fixed on top of the gas holder. Inlet and outlet pipes were fixed at the bottom of the big drum (outlet for the removal of the liquid biofertilizer and inlet for introduction of liquid waste, water during the process). These pipes were made of PVC of diameter 64mm, the length of the outlet pipe was 100mm and that of the inlet was 1310m.

A biodigester is not required to be in direct contact with sunlight but it kept in a place that has a temperature of about thirty-four degrees Celsius during the day. Process performance depends on climate condition, the rate of subtraction of substance from the digester, the materials used in construction, etc.

This process can be subdivided into various stages from the preparation of feed to collection of liquid, they are as follows;

The digester is an incubator that mixes all the constituents and allows it to ferment under anaerobic conditions. Cow dung was mixed with water in a container of volume 20 liters. 12kg of cow dung was mixed with 30 liters of water instead of 40 liters as originally planned this was because I used fresh cow dung i.e. the cow dung still retained some of its moisture. The mixing process was done by hand because there was no provision for a stirrer during the construction of the biodigester.

The fine mixture of cow dung and water formed a thick brown slurry which was then charged into the system. The smaller drum (gas trap) was then inserted upside down into the bigger one to act as a cover.

On top of the gas trap is a hole where an iron pipe is melded to allow the passage of gas, a regulator or tap head is connected to regulate this flow. Two holes of about 60mm was cut at the right and left side of the layer drum before loading the mixture of cow dung and water, they act as the inlet and outlet lines. Two PVC pipes of diameter 75mm is connected to these holes. The length of the inlet pipe is 1,310m while that of the outlet is 100mm. The fermentation process was allowed for 30 days, formation of gas was observed after the third day and it was evident from the rise in level of the gas trap (smaller drum). To avoid excess pressure, build up in the system which could be caused by lack of space for the gaseous compound formed, the gas trap was opened for thirty minutes on day 10, 20, and 30 for the gas to escape. Although, this is environmentally wrong, it was the safest means of given off the gas since there was no provision in the design stage for gas collection.

After 30 days, the outlet line was opened and the biofertilizer was collected through the outlet line.

The chemical fertilizer was gotten from Indorama, a fertilizer producing company in Nigeria. The one selected for use was labelled N:P:K 20:10:10. The chemical fertilizer came in very fine white crystals so to compare it with the liquid extracted from the biodigester, there was a need to put both of them in the same physical start. To achieve this goal, 50 grams of the chemical fertilizer was weighed and then dissolved in 500ml of water resulting in a solution which was used as the chemical fertilizer.The properties of this solution were also sent to the laboratory for tests to be run on them.

The process chosen for this test, was to plant maize in three nurseries after enriching two of the samples with chemical fertilizer and the liquid collected from the biodigester. Steps involved in this process include;

Loamy soil selected as the soil to be used for this process, it was first collected from a farm around Rumuochakara in Choba community of Rivers state. then tiled to remove rocks and other contaminants. Then 1.2kg of the soil was put into three transparent buckets, labelled nursery 1, 2 and 3 respectively.

The nurseries were made from transparent 5liter buckets. Nursery one was enriched with 250ml of the chemical fertilizer, nursery two was enriched with 250ml of the liquid collected from the biodigester while nursery three was kept as a control sample.

A day before the application of the fertilizer, five maize seeds were buried in each nursery. The soil samples were observed over a period of forty days, physical changes

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in the soil samples and growing plant observed daily over this period of time was recorded.

After the thirtieth day, the germinated crops were harvested from their nursery beds for further experiments to be carried out on them. Height of all three samples as well as weight and size of the broadest leave was measured, number of flowers and fruits or seeds produced was also counted and recorded. The values gotten from these measurements was used as a yardstick in drawing a conclusion, values like;

1. Height
2. Weight
3. Length of broadcast leaf
4. Length of the roots

III. RESULTS

Fig.1 – Fertilizer samples results

	Biofertilizer	Chemical fertilizer
pH	4.9	5.1
Nitrogen	0.026mg/l	0.00124mg/l
Phosphorus	3.45mg/l	3.07mg/l
Potassium	650mg/l	3,416.666mg/l
Calcium	325mg/l	11.65mg/l
Sulphate	1.11mg/l	1.10mg/l

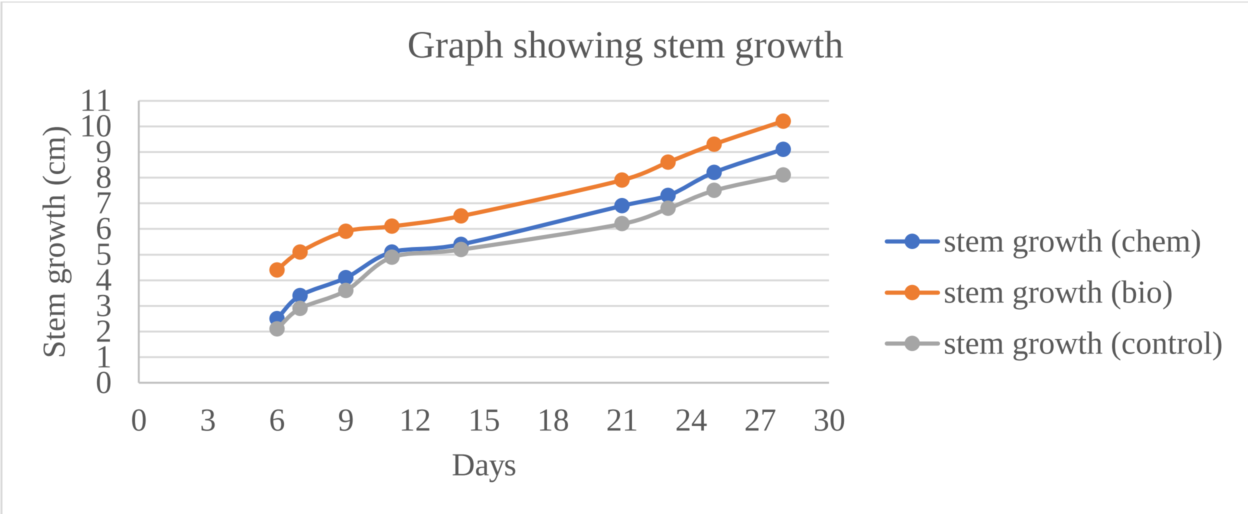

Fig.2 – Graph showing stem growth

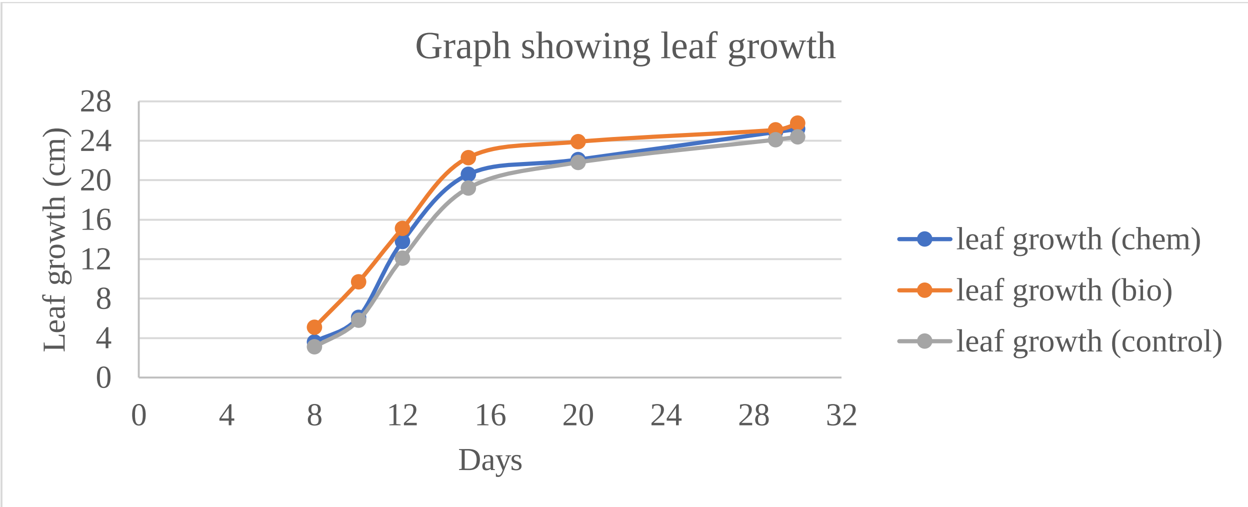

Fig.3 – Graph showing leaf growth

Fig.4 – Table showing the final measurement of harvested crop at after 30 days

	Height	Weight	Length of broadest leaf	Number of flowers present	Number of seeds present	Length of the roots
Chemical	45.4cm	3.40grams	25.2cm	None	None	10.3cm
Biofertilizer	47.6cm	4.82grams	25.8cm	None	None	11.4cm
Control	43.2cm	2.55grams	24.4cm	None	None	10.1cm

IV. DISCUSSION

The conversion process of cow dung to biofertilizer gave rise to three products namely;

1. A colorless gas with a foul smell
2. A dark brown liquid which also had a foul smell and had traces of living microorganisms in it.
3. A thick slurry which was composed mainly of the moist fermented cow dung.

The results from figure one show that the biofertilizer is rich in potassium, calcium and phosphorus; this means that when it gets into the soil there would, be an increase in the availability of these nutrients which will go a long way to plants with higher root development rate, stronger stems with more water movement ability hence, promoting the formation of seeds, flowers and fruits with a slightly acidic pH. For the chemical fertilizer, the potassium content is very high but nitrogen relatively low. This may give rise to a plant with enhanced root and stem development but not so strong leaf growth rate. The pH of the chemical fertilizer was just a little bit neutral when compared to that of the biofertilizer.

The seed which germinated the fastest out of the six planted was used the main focus of observation. The tallest of all growing crops in each soil sample after day 15 was chosen to be the fastest germinating seed.

For nursery one, not all the seeds germinated but this was more of a seed problem and not an issue with the fertilizer applied. The growth rate process increased properly until it got to a point when some of the leaves began to wither away but only one of the plants completely died although almost all the growing plants had leaves that withered. The weed formation rate for this nursery was relatively slow when compared to that of the chemical fertilizer. This nursery had the best look in terms of color at the start but began to slowly lose part of its color towards the end of the study.

The biofertilizer nursery was swift to outrun the other nurseries in terms of stem height and leaf formation and growth rate. The coloration of leaves and stem began slowly but eventually outshined the chemical fertilizer and the control. A few leaves withered but this was towards the end of the observation period, which was assumed to be as a result of over nutrition on the nursery.

The control nursey, as expected followed the fertilized nurseries behind in terms of stem growth and leaf formation rate, there was a very low occurrence of withering in the nursery and this goes to affirm the assumption for the reason for the withering of leaves.

Overall, it was observed that plants absorbed sunlight for photosynthesis and growth but the visible growth process was always late in the night or early in morning when water movement was really visible. Soil in each nursery weighed 2 grams and the withering of leaf goes to show that, 250ml of any fertilizer is to a large extent too much for that portion of soil.

Figure 2 showed that the biofertilizer led the other nurseries in stem growth rate. Towards the end of the observation time, the control moved closer to the chemical fertilizer but the chemical fertilizer soon began to outshine its growth rate but never was any close to the biofertilizer.

Figure 3 shows the leaf growth and although the biofertilizer leads the chats in this graph, they all tend towards having a uniform value. The acceleration also decreased as the days went by while leaf formation rate increased; this may be as a result of the leaves getting close to their highest length for that said period of time. The low boost in the rate of growth of leaves in all nurseries was also assumed to be because of the lack of adequate nitrogen in any of the fertilizers.

Low observation time did not allow the process of seed and flower formation to be documented. The observed increase in stem diameter and weight of the biofertilizer nurseries as compared to that of the chemical fertilizer, shows that the biofertilizer will produce a stronger and more durable crops. Root, stem and leaf growth were all led by the biofertilizer nurseries which suggested that it is indeed a better growth enhancer than the chemical fertilizer.

V. CONCLUSION

The result of the tests on the liquid product of the anaerobic degeneration of cow dung in a biodigester means that agricultural wastes such as cow dung can be utilized to produce other useful produces such as biogas and biofertilizer which can be used as an alternate source of energy and another technique in waste management. Also, it told us that the slurry (byproduct) of the anaerobic degeneration of cow dung or any other biological waste can serve as a very good manure for the average agriculturist.The liquid gotten from the anaerobic degeneration of cow dung was made up of 0.026mg/l Nitrogen, 3.45mg/l Phosphorus, 650mg/l Potassium, 325mg/l Calcium, and 1.11mg/l.

The properties of the crops that germinated from the three different soil samples used meant that the chemical fertilizer increases growth rate of crops but at the same time is harmful to the soil and the crops been grown on it – this gives rise to the growth of leaves, flowers and fruits that tend to deviate from the norm and in some worst case scenarios, it may lead to death of the plant. It further should that the liquid from the anaerobic degeneration of cow dung now known as liquid biofertilizer has been tested to be very good for plant and soil nourishment. The liquid from the anaerobic degeneration of cow dung does not just possess nutrients for soil nourishment but also has living microorganisms that aids the reactions that occur naturally in the soil, hence making its effect stronger than that of the chemical fertilizer.

VI. RECOMMENDATION

It is recommended that;

a) Low cost designs should be encouraged so as to facilitate biofertilizer production
b) Orientation program on how to turn waste (plant and animal) into wealth should be given to farmers.
c) Government should create policies that forces produces of chemical fertilizers to spell out the harmful effect their product has on the soil, the farmer and his crops.
d) There should be research and development programs to create microbial catalyst so as to help increase the rate of anaerobic degeneration in the biodigester.
e) Further research should be carried out in this field to check not just the growth rate but also productivity time and yield to give a better conclusion as to which source of fertilizer is the best.
f) For large commercial purpose, there is a need to develop a process for the purification of the liquid biofertilizer – most importantly for the removal of its foul smell.

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