Trends in Applied Sciences Research

ISSN 1819-3579

Academic
Journals Inc.

www.academicjournals.com

OPEN ACCESS Trends in Applied Sciences Research

ISSN 1819-3579
DOI: 10.3923/tasr.2019.186.192

Research Article
Assessing the Effects of Some Organic Manure on Microbial Profile of the Soil and Plant Growth

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Abstract

Background and Objective: Organic manure has been considered as a significant resource in supporting soil fertility which impacts positively on soil microbial population and plant performance in the tropics. This research was aimed at determining the effect of organic manure on the microbial population of the soil and plant growth. **Materials and Methods:** Portions of soil samples weighing 1000 g were collected into polyethylene bags and organic manure which were poultry manure, cow manure, pig manure and goat manure were each added to each 1000 g portion of the soil in the ratio of 10:1, 10:2.5 and 10:5 for each organic manure. **Results:** The result of the effect of some organic manure on microbial profile of soil and plant growth analyzed using standard microbiological methods revealed significant microbial count and plant growth for days 1, 4, 7 and 10. The highest mean microbial count was recorded in soil amended with pig manure, followed by soil amended with goat manure, while the control soil sample recorded the least colony count for days 1, 4, 7 and 10. The study also revealed the presence of *Staphylococcus* sp. (35.5%), *Clostridium* sp. (11.57%), *Listeria* sp. (5.3%), *Serratia* sp. (3.0%), *Enterococcus* sp. (3.0%) and *Pseudomonas* sp. (10%). While fungal isolates with percentage frequency of occurrence were; *Aspergillus* sp. (12.7%), *Penicillium* sp. (12.7%), *Rhizopus* sp. (17.7%), *Geotrichum* sp. (10.1%), *Trichosporon* sp. (16.9%) and *Fusarium* sp. (15.2%). Seed germination revealed that soil amended with pig, goat and poultry manure as well as the control recorded 100% germination at day 4, while soil amended with cow manure recorded 75% germination. Plant height in soil amended with pig manure ranged between 485 and 495 mm at day 10, followed by plant in soil amended with goat manure which ranged between 445 and 465 mm at day 10. The control had the least plant height which ranged between 300 mm at day 10. **Conclusion:** Soil amended with organic manure had a positive influence on soil microbial and plant growth but pig manure observed to have the most positive effect on soil microbial profile and plant growth. Pig manure and goat manure has therefore been recommended for soil amendment compared to poultry and cow manure for improved soil fertility.

Key words: Organic manure, soil, micro-organisms, plants

Citation: Aniefon Alphonsus Ibuot, Iniobong Ime James, Patience Saturday Akpan, Mayen Godwin Ben, Christiana Utibe Etuk and Emmanuel Anthony Umoren, 2019. Assessing the effects of some organic manure on microbial profile of the soil and plant growth. Trends Applied Sci. Res., 14: 186-192.

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Animal manure (called manure) according to Defoer *et al.*[1] is organic manure consisting of partly decomposed mixture of animal dung and urine. Manure has been acknowledged as a major resource in sustaining soil fertility in the tropics, supplying the soil with a variety of macro and micronutrients and organic matter[1].

Organic manures contribute greatly to the fertility of soil by adding organic matter and nutrients, such as nitrogen, trapped by soil micro-organisms. These micro-organisms are fed by higher organisms in a life chain made of the soil food web. Organic manure can also be obtained on decomposition of organic matter like animal dung, it adds essential elements and humus to the soil[2].

Organic manures when used have beneficial effect upon soil and crops, their use are expected to improve crop production yielding rewarding dividends[3]. On the other hand, application of organic manures, crop yield is expected to stabilize over the years, indicating substantial improvement in soil fertility. The use of poultry droppings, cow dung, pig dung and goat manure increase the soil fertility by providing secondary and micronutrients. Soil fertility is an important form of renewable natural capacity[4]. A fertile soil which is productive results most often in yield increase giving profit to farmers[5]. Harsh climatic conditions, population pressure, land constraints and the decline of traditional soil management practice results in decline of soil fertility. A marked declined in crop productivity and food security are the main consequences of the policies that result in soil fertility depletion[4].

The use of organic manure is of great advantage, because it contains many nutrients required by plant for optimal performance and also helps in improving soil texture and structure. The application of organic manure has been found to increase soil pH[6,7]. Organic manure are essential constituent of soil, they represent in variety of forms ranging from plants and livestock materials. Tivy[8] while describing the components of organic manure noted that organic manure comprises of waste and residues from crops and livestock. He further reported that farm yard manure is not really capable of returning more than 50% of the nitrogen, phosphorous and potassium to the soil. The use of organic manure when properly applied, benefits fruiting in plant like maize and generally enhance size, height and number of leaf. This work will therefore determine the effect of some organic manure on the microbial profile of the soil. Also, will determine the effect of some organic manure on plant growth and will make necessary recommendations based on the results of this work.

MATERIALS AND METHODS

Description of study area: This research work was carried out in the Botanical garden of Akwa Ibom State Polytechnic, Ikot Osurua, Ikot Ekpene, Nigeria. This work was done in the month of September 2017 and it lasted for three months.

Sample collection and preparation: Soil sample weighing 1000 g was carefully weighed each into polyethylene bags and poultry manure, cow manure, pig manure and goat manure were added to each 1000 g soil in the following ratios; soil and poultry manure (S: Po 10:1, 10:2.5, 10:5). Soil and cow manure (S: Co 10:1, 10:2.5, 10:5), soil and pig manure (S: Pg 10:1, 10:2.5, 10:5), soil and goat manure (S: Go 10:1, 10:2.5, 10:5). Each soil sample was thoroughly mixed with the organic manure respectively and controls (untreated soil) the poly bags were properly labeled. Four seeds of maize (*Zea mays*) were planted in each poly bag containing soil amended with a particular organic manure and the controls (untreated soil).

Microbiological analysis: Soil samples for each treatment were analyzed for total bacterial count (TBC) and total fungi count (TFC) carried out serial dilution of each treated soil sample and the control and 1 mL inoculum of a known dilution factor inoculated in nutrient agar and Sabouraud Dextrose Agar (SDA) for bacterial and fungal growth. The prepared plates were incubated at 37°C in the incubator for 24 h after which microbial colonies were counted. Bacterial isolates were characterized using cultural, morphological and biochemical characterization which include Gram-stain, catalase test, methyl red test, indole test, urea test, spore stain, motility test, coagulase test and sugar fermentation test and identified according the method of Cheesbrough[9] and Holt *et al.*[10] and fungal isolates were characterized and identified using their macro-morphological, microscopic examination in lacto-phenol cotton blue stain for viewing hyphae, reproductive structures, filaments, spores head etc.

Seed germination studies: The seed germination study was carried out after an interval of 4 days to determine the number of seeds that have germinated using the method of Jinadasa *et al.*[7].

Determination of plant growth: Plant growth was determined by measuring plant height with use of a meter rule, plant girth was measured using calipers and number of leaves at 4 days interval was determined by counting the number of leaves.

Statistical analysis: Mean±SE and a two-way ANOVA were used for statistical analysis in this study.

RESULTS

Total bacterial count of soil samples: Total bacterial count of soil samples amended with animal manures showed soil amended with pig manure, goat manure and poultry manure having high bacterial counts compared to soil amended with cow manure and the control was observed to have relatively low bacterial counts (Fig. 1-4).

Total fungal count of soil samples: Total fungal count for the soil samples amended with animal manure were observed to have the same trend except for the control which recorded a low fungal count compared to the amended soil samples (Fig. 5-8).

Bacterial percentage frequency of occurrence in soil samples: Bacterial percentage frequency showed Pseudomonas sp. with the highest percentage frequency of occurrence 35.5%, followed by *Bacillus* sp. 31.5%, *Clostridium* sp. 11.5%, *Staphylococcus* sp. 10%, *Listeria* sp. 5.3% while *Enterococcus* sp. had 3.0% (Fig. 9).

Fungal percentage frequency of occurrence in soil samples: Fungal percentage frequency of occurrence showed *Penicillium* sp. with 27.1%, *Rhizopus* sp. 17.7%, *Trichosporon* sp. 16.9%, *Fusarium* sp. 15.2%, *Aspergillus* sp. 12.7% and *Geotrichum* sp. 10.1% (Fig. 10).

Seed germination studies: Germination studies of seed showed 100% germination for soils amended with pig, goat and poultry manure. While soil treated with

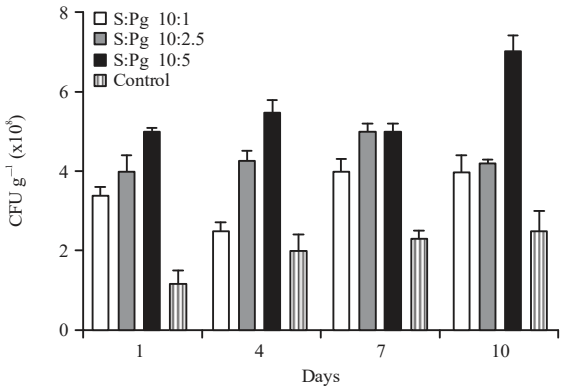

Fig. 1: Total Bacterial Count (TBC) of soil amended with pig dung

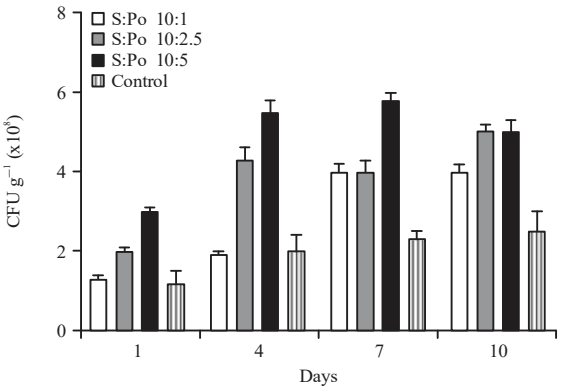

Fig. 3: Total Bacterial Count (TBC) of soil amended with poultry droppings

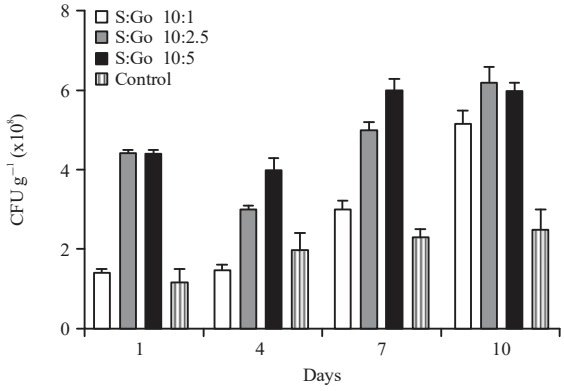

Fig. 2: Total Bacterial Count (TBC) of soil amended with goat dropping

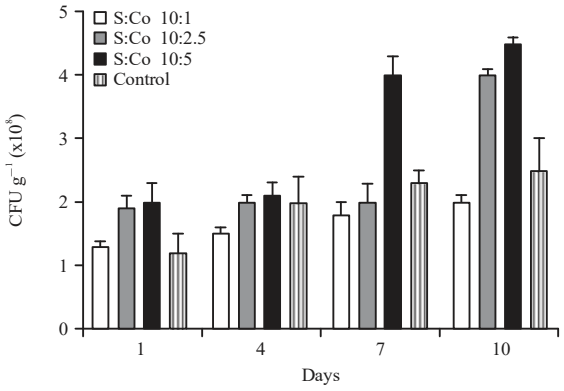

Fig. 4: Total Bacterial Count (TBC) of soil amended with cow dung

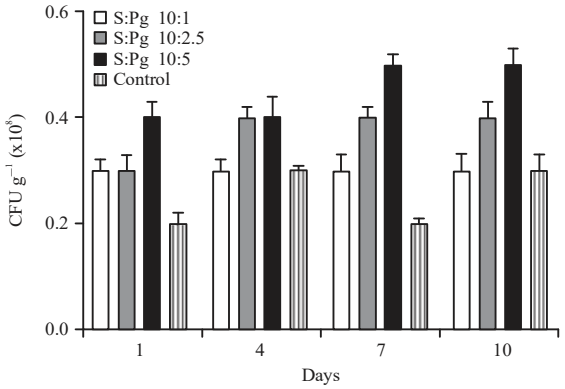

Fig. 5: Total Fungal Count (TFC) of soil amended with pig dung

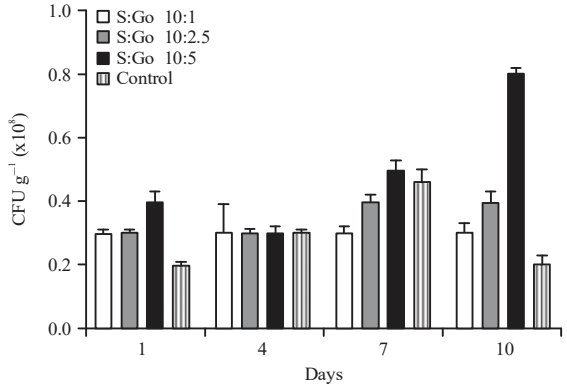

Fig. 6: Total Fungal Count (TFC) of soil amended with goat manure

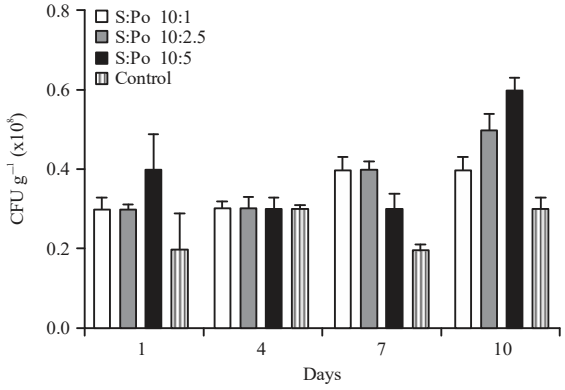

Fig. 7: Total Fungal Cont (TFC) of soil amended with poultry droppings

cow dung showed 75% seed germination. The control however showed 100% seed germination (Table 1).

Plant height, girth and number of leaves: Plant height and girth showed soil amended with pig dung having highest

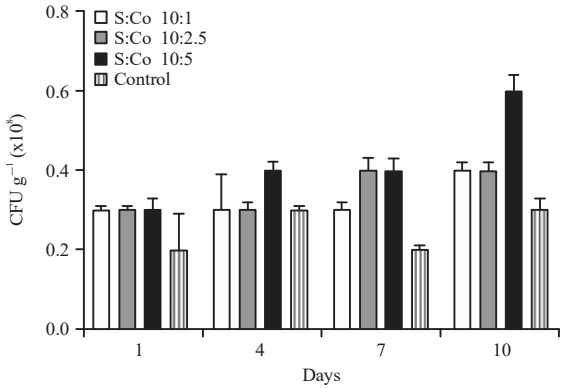

Fig. 8: Total Fungal Count (TFC) of soil amended with cow dung

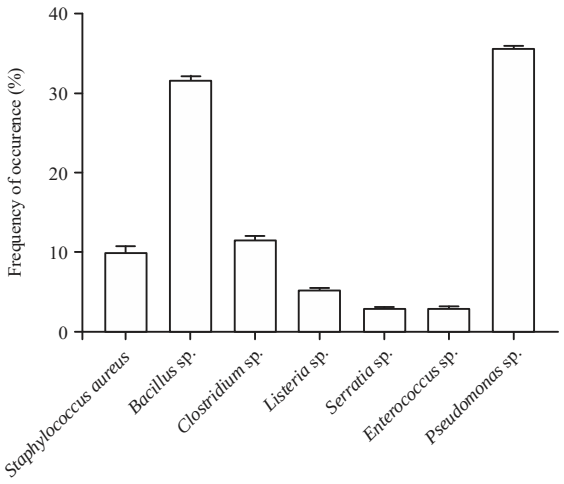

Fig. 9: Frequency of occurrence (%) of Bacteria is soil amended with organic manure

Table 1: Germination (%) of maize (*Zea mays*) seeds planted in soil amended with different animal manure

Samples	Germination (%)
S:Pg	
10:1	100
10:2.5	75
10:5	100
S:Go	
10:1	100
10:2.5	75
10:5	100
S:Po	
10:1	75
10:2.5	75
10:5	100
S:Co	
10:1	75
10:2.5	50
10:5	75
Control	100

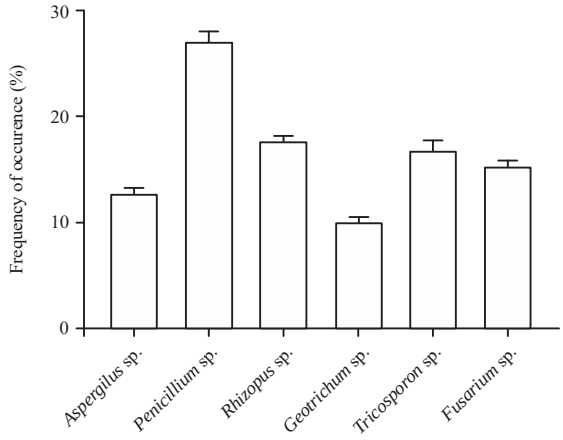

Fig. 10: Frequency of occurrence of fungi (%) in soil amended with organic manure

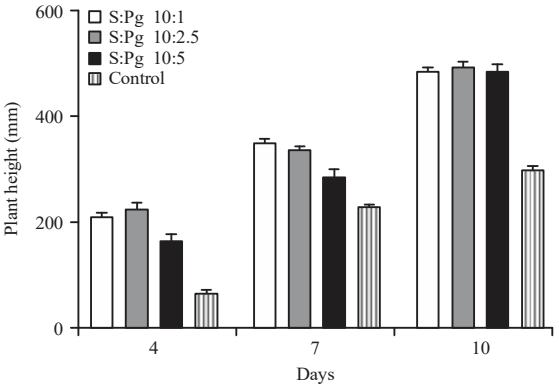

Fig. 11: Height of maize (*Zea mays*) planted in soil amended with pig dung

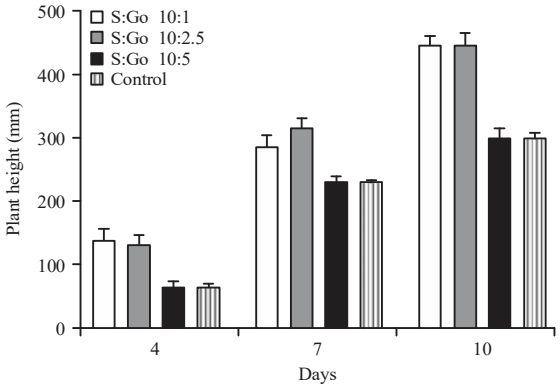

Fig. 12: Height of maize (*Zea mays*) planted in soil amended with goat dung

plant height followed by soil amended with goat, while soil with cow manure had recorded the lowest among soils treated with organic manure (Fig. 11-14, Table 2). The

Table 2: Girth of maize (*Zea mays*) plant in soil amended with different animal manure (mm)

Samples	Day 4	Day 7	Day 10
S:Pg			
10:1	14±0.34	14±0.33	16±1.23
10:2.5	14±0.45	16±0.98	17±0.46
10:5	14±0.64	14±4.23	19±4.23
S:Go			
10:1	15±1.23	16±3.22	17±4.03
10:2.5	15±2.05	16±4.21	17±4.23
10:5	14±2.67	16±0.11	17±0.18
S:Po			
10:1	15±3.12	15±0.12	13±1.23
10:2.5	12±0.89	13±0.19	13±2.14
10:5	13±0.99	13±2.32	14±0.99
S:Co			
10:1	14±1.24	14±8.23	15±1.80
10:2.5	14±2.15	15±2.18	16±2.10
10:5	13±4.12	14±0.12	15±1.90
Control	13±0.36	13±0.46	14±0.89

Table 3: Number of leaves of maize plant (*Zea mays*) in soil amended with different animal manure

Samples	Day 4	Day 7	Day 10
S:Pg			
10:1	2±0.90	3±0.89	4±0.89
10:2.5	2±0.78	3±1.67	4±1.09
10:5	2±1.09	3±1.34	4±1.89
S:Go			
10:1	2±0.99	3±0.98	4±0.98
10:2.5	2±1.56	3±0.78	4±1.02
10:5	2±0.78	3±1.09	4±0.98
S:Po			
10:1	2±1.89	3±0.56	4±1.01
10:2.5	2±1.55	3±0.54	4±0.56
10:5	2±1.23	3±0.90	4±0.24
S:Co			
10:1	2±2.09	3±1.09	4±0.15
10:2.5	2±2.01	3±1.02	4±0.98
10:5	2±1.09	3±0.45	4±0.67
Control	2±2.10	3±0.98	4±0.34

numbers of leaves were observed to be relatively equal in number for all the plants in the different amended soil samples (Table 3).

DISCUSSION

Application of organic manure to soil is one important practical approach to improve soil fertility, which in turn improves plant nutrients for crops growth and yield as well as enhancing soil microbial activity of soil as reported by Sun *et al.*[2]. The result of bacterial count of soils treated with organic manure showed soil treated with pig dung with highest bacterial count, followed by soil amended with goat manure and then soil amended with poultry droppings, while the control soil without amendment had the least total bacterial count. A similar trend was observed in total fungal

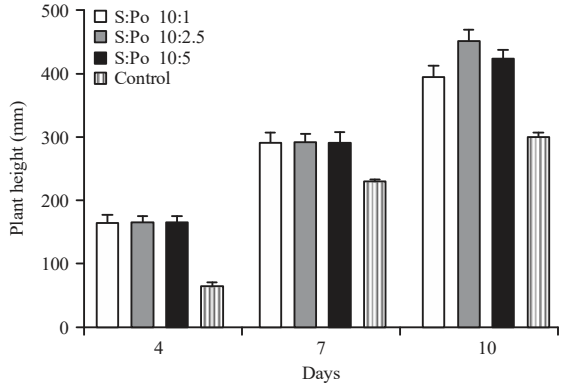

Fig. 13: Height of maize (*Zea mays*) planted in soil amended with poultry droppings

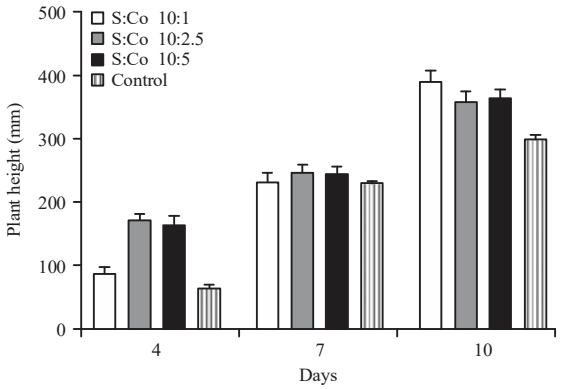

Fig. 14: Height of maize (*Zea mays*) planted in soil amended with cow dung

count of the soil samples. The result is in line with the result of Sun *et al*.[2], who reported increase in the microbial profile of soil amended with organic manures. The result reflected a highest microbial profile from soil samples amended with pig and goat manure which agrees with the work of Lin *et al*.[11]. The increase in the microbial load of the soil sample amended with pig dung and goat manure could be as a result of the organic manure acting as a substrate, media and or creating a favorable environment for the growth of the micro-organisms. Zhang *et al*.[12] also reported that organic manure promotes the growth of bacteria. The study revealed the presence of *Staphylococcus* sp., *Bacillus* sp., *Clostridium* sp., *Listeria* sp., *Serratia* sp., *Enterococcus* sp. and *Pseudomonas* sp. as bacterial isolates. The result of this study is in line with the work of Ogbonna *et al*.[13] while result of the analysis revealed the presence of *Staphylococcus* sp., *Bacillus* sp., *Pseudomonas* sp., *Corynbacterium* sp. and *Enterococuus* sp. The presence of *Staphylococus* sp. was not surprising as it has been reported by Dalal[14], which he suspected could be as a result of the presence of the organism on the skin and feather of the farm animals which must have contaminated the animal manure. *Listeria* sp., *Serratia* sp. and *Enterococcus* sp. are associated with animal dungs. The presence of *Psuedomonas* sp. was not surprising as it has been reported to be soil bacteria[13].

Fungal isolates from the soil samples were *Aspergilus* sp., *Penicillium* sp., *Rhizopus* sp., *Geotrichum* sp., *Tricosporon* sp. and *Fusarium* sp. This agrees with the work of Bossio *et al*.[15], who reported the presence of *Rhizopus* sp., *Aspergillus* sp., *Mucor* sp., *Actinomyces* sp., *Streptomyces* sp., *Geotrchum* sp., *Tricosporon* sp. and *Fusarium* in soil amended with animal manure.

The result of seed germination study from soil amended with different organic manure revealed that soil samples amended with pig dung, goat manure and poultry dropping recorded 100% seed germination at day 4, this result agrees with the work of Lin *et al*.[11]. Soil sample amended with cow dung had 75% seed germination, which agrees with the work of Amujoyegbe *et al*.[16], who reported that some animal manure altered the rate of germination of cereal seeds. Pig dung, goat manure and poultry droppings could be considered a better organic amendment for soil probably because of its ability to create a favorable condition for seed germination.

Zea mays planted in soil sample amended with pig dung recorded very high growth, as determined by the plant heights, girth and number of leaves followed by plants in soil sample amended with goat manure and poultry dropping amended soil sample. This work agrees with the work of Lin *et al*.[11]. Ogbonna *et al*.[13] also reported high plant growth rate from soil amended with animal manure when compared to the control which agrees with this study. The presence of organic manure in the soil is reported to have positive effect on soil parameters. Sanchez *et al*.[4] reported that its presence in the soil increases soil pH. While Zhu *et al*.[2], reported that it replenishes the soil with essential elements and adds humus to the soil. These factors contributed to higher microbial growth as well as increase in plant growth in the soil and thereby supported the study of Wilczek and Mariappan[17]. Therefore organic manure (animal manure) should be used in planting as it increases the growth of plants and microbial content of the soil, these micro-organisms play a significant role in the proper degradation of organic waste for easily accessibility by plants. Animal waste or organic manure should also be composted for a short time before applying it on the soil as this will help reduces high microbial activities as leading to increase in temperature which may affect seed germination, like in the case of cow dung.

CONCLUSION

Zea mays planted in soil sample amended with pig dung recorded very high growth, as determined by plant heights, girth and number of leaves followed by plants in soil sample amended with goat manure and poultry dropping amended soil sample. Organic amendment therefore affect the structure of the soil, adds organic matter to the soil, which increases microbial activity and soil fertility, hence increase in plant growth and yield.

SIGNIFICANCE STATEMENT

This study discovered that pig dung and goat manure are very good for soil amendments and can be beneficial for increase in soil fertility, plant growth and performance thereby enhancing crop production. This study will help the researchers to uncover the possible reasons why pig dung and goat manure stands out as very good soil conditioners compared to poultry manure and cow manure which many researchers were not able to explore. Thus a new theory on the plant nutritional composition and nutrients availability of these organic manures may be aimed at.

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