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Net Carbon Sequestration and Emission Potential on Lawns in the Federal University of Technology, Akure (Futa) Ondo State, Nigeria

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ABSTRACT

The carbon sequestration rate in lawns with Cynodon dactylon and Paspalum dilatatum grass species were examined within the Federal University of Technology Akure, Ondo State, Nigeria. The study also ascertained the carbon emission rate and the Bacteria and Fungi population count in the study area. Grass samples in the lawns were selected by mapping out 0.5m x 0.5m in three replicates on the same lawn square across all the study locations, then carbon content of the grass was estimated using Schlesinger formula "C= 0.475 × B", where; C is carbon content by mass, 0.475 is a constant and B been the oven-dry biomass, gas entrapment method was used to estimate the carbon emission rate and laboratory experiments were used to ascertain the bacteria and fungi population count in the study sites. The result of the study revealed that the lawn grasses sequesters carbon at an average of 135kg/m and Cynodon dactylon was found to sequester the least with a carbon sequestration rate of121.16kg/m. It was revealed that there were no significant (P≤0.05) differences in the carbon emission potentials of the lawn grasses while there was a significant (P≤0.05) difference in bacterial population count and fungal population count among the study locations. The results concluded that grass species found in lawns within the study area can serve as a terrestrial carbon sink for storage of carbon for a long time.

Keywords: *Carbon sink, climate change,*

INTRODUCTION

Carbon is found in all living organisms and is the major building block for life on Earth. Carbon exists in many forms, predominately as plant biomass, soil organic matter, and as the gas carbon dioxide (CO2) in the atmosphere and dissolved in seawater. Through the process of photosynthesis, plants assimilate carbon and return some of it to the atmosphere through respiration. However, the unwise use of plants and cruel destruction is in an escalating state, without the thought of its extreme consequences such as global warming and climate change. These activities according to Khallaf 2011, releases about 18% of greenhouse gases (GHGs).Rapid change in climate and increase in greenhouse gases in the atmosphere has posed a potential threat to humans coupled with extinctions of flora and fauna which had promoted the need for much research in climate change mitigation strategies in the 21st century. The CO2 emission must be reduced in order to reduce the climate change. There are two basic approaches to reduce CO2 in the atmosphere which are the reduction its sources and capturing (sequestration) and storage. However, reducing the sources of CO2 might take great effort, especially for the developing country. So, the second approach which is to capture (sequestration) and store the CO2 is often utilized.

Carbon sequestration is the process of capturing and long- term storage of atmospheric carbon dioxide (Roger & Brent, 2012). Carbon sequestration is a process of capturing carbon dioxide (CO2) from the atmosphere and long term storage of carbon in oceans, soils, vegetation (especially forests), and geologic formations. This process is essential to reduce

the overheated of the earth that caused the climate change effects. Therefore, the carbon sequestration is seen as an important strategy to help mitigate the increasing emissions of the carbon dioxide into the atmosphere and its adverse effect of climate change (Eneji, 2014).

Soil and plants is one of nature's mechanisms that sequester the carbon from the atmosphere and store it in its reservoirs and Lawn grasses just as other crops and plant ecosystems, also play key roles in removing carbon from the atmosphere and storing it in soils through the process of photosynthesis in which plants absorb CO2 from the atmosphere and synthesize it into various sugars. Lawn grass is a good sequesterer of atmospheric carbon according to research by (Qian, 2012). Yaling's research determined that up to 800 lbs (pounds) of carbon per acre per year is being sequestered by lawn grass which is almost a half of a ton per acre, and it is significant. According to her reports, practices like mowing, returning clippings, feeding and watering actually increases the lawn ability to sequester carbon, the healthier the lawn (well managed lawn), the more carbon it sequester.

The natural agents for carbon sequestration (capture and storage) are plants, forest, soil, ocean and atmosphere. Many deliberations have evolved in recent times on differences in the effectiveness of trees and native grasses in serving as carbon sinks (Piperno, 2006) . It has been reported that trees and forest soils store more carbon than grasslands and grass vegetation (Pouyat et al. , 2006) while some even argues that the lawn grasses and turf grasses might sequester more carbon as a result of mowing, returning clippings and other activities carried out on them (Yaling,2003).

Hence, this research concentrates on the carbon capture by lawns in the study area using several experimental methodologies. The main objective of this research was to estimate the net carbon sequestration potential, carbon emission and soil microbial population count responsible for soil respiration in lawns of the Federal University of Technology, Akure.

MATERIALS AND METHOD

Study Area

The research will be conducted at The Federal University Of Technology, Akure (FUTA) Ondo State which is situated in South-Western part of Nigeria and lies between latitude 50 45" and 80 15" North and longitude 40 30" and 60 East with coordinate of,70 15' 0" N, 50 11' 42"E.

The climate is hot and humid; the rainy season lasts from April-October, with rainfall of about 1524mm per year.

Temperature varies from 280c to 31 0 c with mean annual relative humidity of about 80%.

Sampling Design

The sampling population for this study is lawns found within the Federal University of Technology, Akure.

However, purposive sampling procedure was used to select four different sampling locations because they are well managed and found healthy.

This action is based on the principle that managed/ healthy turf grass and lawns sequester more carbon than unmanaged lawns.

Location 1

School of sciences (SOS), the faculty building is well landscaped with lawn grass which is bahama grass (Cynodon dactylon),

Location 2

School of agriculture and agricultural technology (SAAT), the faculty building is well designed having a wide area/space for car parks and lawn grasses predominantly by Portharcourt grass (Paspalum dilatatum) within and outside with moderate dense tree canopy,

Location 3

School of earth and minerals science (SEMS), the faculty has spaces designated for parking lots, an open space with moderately dense tree canopy and lawn grass i.e Portharcourt grass (Paspalum dilatatum) within and outside,

Location 4

Senate building (SB), this site is well distributed with lawn grass Portharcourt grass (Paspalum dilatatum) with few shrubs and high distribution of trees.

Analytical Techniques

Grass samples were selected 0.5m x 0.5m in three replicates on the same lawn square, this was done for each sampling locations and subsequently used to estimate for the study area in FUTA. To estimate for the carbon

sequestered on lawn grasses, the biomass will be determined with carbon being 50% of biomass.

Estimation of Carbon Sequestration

To estimate the carbon sequestration of the sampled lawns, grass samples were selected by mapping out 0.5m x 0.5m in three replicates on the same lawn square, this was done for each sampling locations and subsequently used to estimate for the study area in FUTA. To estimate for the carbon sequestered on lawn grasses, the biomass was determined with carbon being 50% of biomass. And the carbon content of the vegetations was estimated using Schlesinger formula "C= 0.475 × B", where; C is carbon content by mass, 0.475 is a constant, B is oven-dry biomass (Schlesinger; 2009). However, Schlesinger, 2009 noted that C content of biomass is almost always found to be between 45% and 50%.

Data were collected on the change in dry biomass of grass samples after every 1hour and 30 minutes out of the oven, for four consecutive times till the final dry weight when there was no more reduction in grass biomass. This was done for each of the grass sample replicates.

Measurement Of Carbon Emission Through Soil Microbial Respiration

The gas entrapment method was used in the study (Hutchinson and Mosier, 1981). A 10 mL solution of 0.5 M NaOH was dispensed into a beaker and placed on top of the soil inside each plastic jar to trap CO2 evolved from the soil. Additional beaker containing 10 mL of 0.5M NaOH was placed in a separate jar without soil to serve as control to account for any CO2 trapped from the atmosphere. The trapping solutions were changed on weekly bases all through the 12 - week incubation period. The jars were opened and the NaOH beakers gently removed, covered with aluminum foil and passed on for immediate CO2 determination. The jars containing soil samples were kept open during the titration procedure. This was done to replenish O2 in the jars for the next incubation period.

For the laboratory analysis of soil CO2 efflux, at the end of each week, 1M BaCl2 was added to the NaOH beaker to precipitate the carbonates to facilitate determination of CO2 evolved from the soil. The evolved CO2 was then determined by titration. Excess NaOH in solution was titrated against 0.5 M HCl using phenolphthalein indicator after precipitating the carbonate formed with 1.0 M BaCl2. Data collection was done at 1, 2, 3 and 4 weeks after treatment (WAT) application. Samples were analyzed for the determination of soil respiration determined on weekly basis by titration with HCl.

Microbial Population Count

For the microbial analysis of soil samples i.e.to assess the total microbial population and type of organism in the soil of the study site, a small portion of the soil samples (10cm depth) was transported from the sites inside aluminum foil to the laboratory, a total of six samples was evaluated. Soil samples collected was stored at 40c between 18 to 24hours.

For the Sterilization and preparation of media, the Growth media and diluents (distilled water) were autoclaved at 1210 c for 15minutes. The soil sample was mixed, and a suspension of 1g (Dry weight equivalent) in 20ml of distilled water was prepared. 1mL of the soil suspension was then diluted serially and used in the estimation of aerobic heterotrophic bacterial and fungal populations by standard spread-plate dilution method in duplicate. The media used were malt nutrient agar and nutrient agar.

For the total population count in estimating total bacteria, sterile nutrients agar plates was aseptically inoculated and incubated at 300c for 24hours after then plates of distinct different colonies was counted and was sub cultured in another nutrient agar in other to get the specific bacteria available in that soil. In estimating total fungi, sterile malt nutrient agar plates was aseptically inoculated and incubated at 300c for 72hours after then plates of distinct colonies was counted. To prevent the growth of bacteria in the media, streptomycin was injected in the agar. Data were then collected on population count of organisms (bacteria and fungi).

Results And Discussion

Carbon Sequestration Rate in Lawns in the Study Area

Analysis of carbon sequestration rate in the respective study locations (SOS, SAAT, SEMS and SB) shows that lawn grasses sequesters carbon with high stock rate across the study area which is in agreement with the findings of Yaling et al. 2002. Table 1 revealed that the least stock of carbon stored (121.16kg) was in the location 1 (SOS) with grass specie Cynodon dactylon compared with the grass specie found

in the other locations (Paspalum dilatatum) which sequesters higher stock although there was no significant differences in the sequestration rate of the treatments. This agrees with the finding of Odiwe et al., 2016 who found out that Cynodon dactylon sequestered lowest carbon as a grass in the Obafemi Awolowo University campus environment.Also, findings from this study is in line with Beard et al., 2009 that found carbon sequestration rate to be high in well managed and maintained lawn grasses. This is also evidently shown in this study, where the carbon sequestration rate was highest (149.21kg) in the location 4 (SB) which is the most maintained lawn in the university environment. It can then be estimated that lawn grasses sequesters at an average of 135kg/m in the study area (FUTA).

Table1. *Results of carbon sequestration rate of lawns in the study area (kg)*

S/N	SAMPLING LOCATION	GRASS SPECIES	CARBON STORAGE
1	SOS	Cynodon dactylon	121.16
2	SAAT	Paspalum dilatatum	135.97
3	SEMS	Paspalum dilatatum	134.70
4	SB	Paspalum dilatatum	149.21

Carbon Emission Potential of Lawns in the Study Area

Gas entrapment method of (Hutchinson and Mosier, 1981) was used to assess carbon emission rates, the samples were analyzed for the determination of soil respiration through soil microbial activities. From the result in table 2 it was evident that location 1 (SOS) with grass specie (Cynodon dactylon) emits minimal carbon due to the microbial population that characterizes it as shown in table 3, compared to other locations (SAAT, SEMS and SENATE BUILDING) with the same grass specie (Paspalum dilatatum) that emits carbon at higher amount due to the microbial population that characterized them also (table 3). However, the result revealed that carbon emission rates had no significant ($P \leq 0.05$) difference and that lawn is a source of carbon emission, this correlates with the work of (Mark, 2012) that lawn contribute to climate change through carbon emission in the grasses planted.

Lawns in the study area (FUTA) emit carbon through soil respiration which implies that they are in support with soil microbial activities (table 2 and table 3). An overview of the result shows soil microbe is a key ecosystem process that emits carbon from the soil in the form of carbon dioxide. (Lipson, 2005).

Table2. *Result of carbon emission through soil microbial respiration in lawn (mg/kg)*

S/N	SAMPLING LOCATION	GRASS SPECIES	WEEKS AFTER SAMPLING				
			1	2	3	4	5
1	SOS	Cynodon dactylon	71.5a	68.6a	69.4a	69.2a	68.1a
2	SAAT	Paspalum dilatatum	83.3a	78.8a	70.7a	71.1a	69.2a
3	SEMS	Paspalum dilatatum	86.5a	80.4a	70.5a	61.1a	71.4a
4	SB	Paspalum dilatatum	89.0a	88.5a	90.6a	91.2a	81.5a

Microbial Population Count

As presented in table 3, there was a significant difference in bacterial population count and fungal population count among the locations. The relative abundance population for bacteria in the different locations within the university campus revealed the dominance of Bacteria in the soil biomass which agrees with the findings of Janusauskaite et al., 2013 and Silva et al.2013 that Bacteria, Actinomycetes and Protozoa can tolerate more soil disturbance than the fungi, hence they dominate in the often tilled/worked soil. Also locations with trees had the highest number of bacteria and fungi count (table 3). Bacteria and fungi population count in location

1 (SOS) is lower as compared to location 4. This suggests that there are relationship between the roots of tree plant and bacteria as well as between fungi and plant roots. Soils of locations with trees contained more bacteria than fungi which are in line with the opinion of Sylvia et al., 2005 that soils covered with trees often contain greater amounts of soil bacteria than fungi. This is because bacteria are less susceptible to changes in soil and environmental conditions unlike fungi which are easily

restricted by soil pH, nutrient and harsh environmental conditions (Sui et al., 2012). Another reason for this could also be as a result of the soil structure and soil depth which causes variation in the population of microbes found in soils (Fierer et al., 2003).

Table3. *Results of microbial population count (X 10-8)*

S/N	SAMPLING LOCATION	BACTERIA (cfu g^{-1} soil)	FUNGI (cfu g^{-1} soil)
1	SOS	63.00b	24.83b
2	SAAT	64.16b	25.83b
3	SEMS	79.00b	34.16ab
4	SB	99.83a	41.16a

CONCLUSION

Analysis of the vegetation (grasses) cover within the study area revealed that Cynodon dactylon and Paspalum dilatatum as lawn grass species have the ability to sequester carbon at a greater rate following the average sequestration rate of 135kg/m in the study carried out. The study indicates that these grasses like every other terrestrial carbon sink can serve as a good sequester. Analysis of the Carbon emission potential in the study location showed that location 1 with Cynodon dactylon emits lower carbon while others emitted higher amount although there was no significant ($P \leq 0.05$) difference and his was attributed to the microbial counts ascertained also in the course of the study. Bacterial and fungal population count were significantly ($P \leq 0.05$) different in the study area due to the observed variations in the elements of the locations like presence of deep-rooted trees and supposed soil structure which all influences microbial count and activities in the soil. The implication of the findings in this study is that lawn grasses has great potentials as carbon sequestered in Federal University of Technology, Akure and hence could be recommended that these grasses are utilized in establishing lawns, managed and highly maintained as they would not only serve the primary aim of aesthetics and landscaping but rather proceed to effectively function in carbon Sequesterer which invariably mitigate climate change and provide health benefits.

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