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Net Carbon Sequestration and Emission Potentials in Selected Herbs at Joseph Sarwuan Tarka University Makurdi, Benue State, Nigeria.

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A B S T R A C T

Lawn plants are a great source of carbon sink and aid in the reduction of greenhouse gases. This study aimed to examine carbon sequestration and emission potentials in lawns plants. Methods: Four sample locations at Joseph Sarwuan Tarka University Makurdi were mapped out by 0.5m× 0.5m with three replicates. Carbon emission rates across study locations were estimated using Schlesinger formula 'C= 0.475× B', where C is the carbon content. 0.475 is the constant, and B is the oven-dried biomass. Results: Carbon dioxide efflux (SCO2E) of herbs sampled resulted to no significant difference (p=0.00). The total carbon storage capacity in each herb was estimated and results revealed that Tridax procumbiens, sequestered more carbon (3.85kg) and has the best carbon sink compared to Sida acuta (2.37kg), Laportea aestuans (3.06kg) and Heterpogon contortus (2.99kg), Synedrella nodiflora (2.07), Cynodon dactylon (2.60kg), Ipomea triloba (2.42kg) and lowest in Axonopus affinis (1.68kg). Various bacteria species were identified using several biochemical tests such as catalyst test, Motility test, idole test, citrate utilization test and urease test. The gas entrapment method measured the total soil microbial respiration and bacterial species present in soil. Bacterial species identified includes; Bacillus sp, Proteus sp, Escherichia coli, Streptoccocus, Klebsiella sp, and Staphylococcus sp. Total soil microbial counts from the rhizosphere of each herb species showed significant difference at ($P \leq 0.00$). Conclusion: The implications of the findings in this study aligns with previous works and suggests that lawn herbs are repository of carbon functioning in the amelioration of climate change impacts and in the sustenance of the ecosystem.

Keywords: Biomass, Carbon, Herbs, Lawn plants, Soil microbials,

1. Introduction

Carbon exists in many forms, predominantly as plant biomass, soil organic matter, and in gaseous state as carbon dioxide (CO_2) in the atmosphere and dissolved in sea water. Through the process of photosynthesis, plants assimilate carbon and return some of it to the atmosphere through respiration. It makes up to about 0.025 percent of the earth's crust (Erik Gregersen, 2023). 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 releases about 18% of greenhouse gases (GHGs) (Khallaf 2011). Rapid change in climate and increase in greenhouse gases in the atmosphere has posed a potential threat to human coupled with extinctions of flora and fauna which had promoted the need for much research in climate change mitigation strategies in the 21st century.

Carbon sequestration thus is referred to as the capturing and long-term storage of carbon in either plants, soils, geologic formation or the ocean. Carbon sequestration is associated with the capture of carbon and its compounds from the environment, which reduces the greenhouse effect (Lal *et al.*, 2015). Carbon sequestration occurs both naturally and as a result of anthropogenic activities and typically refers to the storage of carbon that has immediate potential to become carbon dioxide gas. Considerable interest has been drawn to the possibility of increasing the rate of carbon sequestration through changes in land use and forestry, in response to growing concerns about climate change which results from increased carbon dioxide concentrations in the atmosphere. Geo-engineering techniques such as carbon capture and storage is also a method considered. Although, reducing the sources of CO_2 might take great effort down to finance, especially for the developing country which has made carbon sequestered approachable and affordable to any. Therefore, the carbon sequestration is seen as important strategy to help mitigate the increasing emissions of the carbon dioxide into the atmosphere and its adverse effect of climate change (Eneji *et al*., 2014).

In many ways, carbon is life. A chemical element, like hydrogen or nitrogen, carbon is a basic building block of biomolecules and exists on Earth in solid, dissolved as gaseous forms. For example, carbon exists in graphite and diamond, but can also combine with oxygen molecules to form gaseous carbon dioxide (CO_2) (Sedjo *et al*., 2012). Carbon sequestration describes long-term storage of carbon dioxide or other forms of carbon to either mitigate or defer global warming and avoid dangerous climate change. It has been proposed as a way to slow the atmospheric and marine accumulation of greenhouse gases, which are released by burning fossil fuels and industrial livestock production (Abdulla *et al*., 2021).

Carbon dioxide is naturally captured from the atmosphere through biological, chemical or physical processes. Some artificial sequestration techniques exploit these natural processes (Sedjo *et al*., 2012), while some use entirely artificial processes.

Urban forestry increases the amount of carbon taken up in cities by adding new tree sites and the sequestration of carbon occurs over the lifetime of the tree (Mcpherson *et al.*, 2013). It is generally practiced and maintained on smaller scales, like in cities. The results of urban forestry can have different results depending on the type of vegetation that is being used, so it can function as a sink but can also function as a source of emissions (Velasco *et al.*, 2016). In both arid hot regions of the world, trees have an important cooling effect through shade and transpiration. This can save the need for air conditioning which in turn can reduce GHG emissions (Velasco *et al*., 2016). The Aim of this research is to identify the sequesters of carbon in selected species of grasses and herbs (A, B, C, D) which serve as reservoirs and determine emission potential, using gas entrapment method.

Research Objectives are;

i. To estimate the carbon sequestration potential in lawns

ii. To examine carbon emission in lawns

iii. To determine soil microbial population, count responsible for soil respiration in lawns

2. MATERIAL AND METHOD

2.1 Study Area

This research was be conducted at the Joseph Sarwuan Tarka University, Makurdi (JOSTUM) Benue State. lies between latitude 7º 44º N and longitude 8º 32ºE covering an area of 800km^2 with an estimate population of 698,106 people. The vegetation type in Makurdi is Guinea Savannah with annual rainfall between 150-180m and temperature range of 26º C to 29º C.

2.2 Sampling Design

The sampling population for this study is lawns found within Joseph Sarwuan Tarka University Makurdi. However, purposive sampling procedure was used to select four different sampling locations.

2.3 Sample Collection

Eight lawn plants samples were collected from four different locations at Joseph Sarwuan Tarka University Makurdi. The samples include; Carpet grass (*Axonopus affinis*), Bermuda grass (*Cynodon dactylon*), Synedrella (*Synedrella nodiflora*) and Convolvulaceae (*Ipomoea triloba L.*), Blak Spear grass (*Heteropogon contortus*), Coat buttons (*Tridax procumbens),* Sida *(Sida acuta),* West Indian wood nestle (*Laportea aestuans),* Study location 1: Front of Science Research Lab, the college building is well landscaped with lawn grass. Study Location 2**:** Opposite New Physics Lab, the laboratory environment has sufficient soil moisture, abundant soil and air moisture, and a wide range of soil with wide area space for lawn grasses predominantly by Synedrella (*Synedrella nodiflora*) within and outside. Study location 3**:** Beside New Science lab, the laboratory has a waste land which accommodates lawns grasses, Study Location 4**:** New Science lab, beside the laboratory is another open field landscape with lawn grasses

2.4 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 Joseph Sarwuan Tarka University Makurdi. 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 "$C= 0.475 \times B$", where; C is carbon content by mass, 0.475 is a constant, B is oven-dry biomass (Schlesinger; 2019). However, Schlesinger, (2019) noted that carbon content of biomass is almost always found to be between 45% and 50%. Data will be collected on the change in dry biomass of grass samples after every 1 hour and 30 minutes out of the oven, for four consecutive times till the final dry weight when there will be no more reduction in grass biomass. This will be done for each of the grass sample replicates.

2.5 Sample Preparation and Inoculation

Small portion of soil samples were collected in an aluminum foil and taken to the laboratory for biochemical test and microbial count analysis.

2.6 Measurement of Carbon Emission Through Soil Microbial Respiration

Measurement of carbon emission potential was done using the gas entrapment method (Hutchinson and Mosler, 1981). A 10Ml solution of 0.5m NaOH was dispensed into a beaker and placed on top of the soil inside each plastic jar to trap CO_2 which would evolve from the soil. Additional beaker containing 10ml of 0.5m NaOH atmosphere. The trapping solutions were changed on weekly bases all through the 12 weeks incubation period. The jar was opened and NaOH beakers gently removed and covered with aluminum foil and passed on for immediate CO_2 determination. The jars containing soil samples was kept open during the titration procedure. This was done to replenish oxygen (O_2) in the jars for the next incubation period.

The laboratory analysis of soil CO_2 efflux was estimated at the end of each week. 1m $Bacl_2$ was added to the NaOH beaker to precipitate carbonates to facilitate determination of CO_2 evolved from the soil. The evolved CO_2 was then determined by titration. Excess NaOH in solution was titrated against 0.5ml hydrogen chloride (HCl) using phenolphthalein indicator after precipitating the carbonate formed with 1.0m Nacl. Data collection was done at 1, 2, 3, and 4weeks after treatment application. (Hutchinson and Mosler, 1981).

2.7 Microbial Population Count

Soil samples collected were stored at 40º C between 18 to 24 hours. Following the sterilization and preparation of media. the growths media diluents (distilled water) were autoclaved at 121º C for 15 minutes. The soil samples were mixed and a suspension of 1g (dry weight equivalent) in 20ml of distilled water, then diluted serially and used in the estimation of aerobic heterotrophic bacterial and fungal populations by standard spread-plate dilution method in duplicate. the total population count in estimating total bacteria sterile nutrients ager plates was inoculated and incubated at 300º C for 24 hours after which plates of distinct different colonies was counted for 24hours and sub cultured in another nutrient agar in order to get the specific bacteria or fungal population available in the soil.

The media used was potatoes dextrose agar and nutrient agar. The total population count in of bacteria was estimated, sterile nutrients agar plates was aseptically inoculated and incubated at 300c for 24hours after which plates of distinct different colonies were counted and sub cultured in another nutrient agar in other to get the specific bacteria available in that soil. In estimating total fungi, sterile potatoes dextrose agar plates were aseptically inoculated and incubated at 300c for 72hours after then plates of distinct colonies were counted. To prevent the growth of bacteria in the media, streptomycin was injected into the agar.

3. RESULTS

3.1 Carbon Sequestration in Lawns Species

Analysis of carbon sequestration rate in different species of lawn *(Heterpogon contortus, Tridax procumbens, Sida acuta, Laportea aestuans, Synedrella nodiflora*, *Cynodon dactylon*, *Axonopus affinis* and *Ipomoea* t*riloba*) shows that lawn herbs sequester carbon with high stock rate across the species. From the analysis in Table 1, *Tridax procubems* had a higher biomass (3.16kg) compared to other lawn species like *Heterpogon contortus,* (2.26kg) *Sida acuta* (1.10kg)*, Laportea aestuans* (1.46kg), *Synedrella nodiflora* (0.30kg). *Cynodon dactylon*, (1.02kg)*, Axonopus affinis* (0.48kg), and *Ipomoea* t*riloba* (0.87kg) respectively. Table 1; Shows the biomass, carbon stocks, total sequestered carbon (TSC) and sequestered carbon dioxide efflux (SCO_2E) of herbs sampled and analyzed, which resulted to no significant difference (p=0.00). Carbon sequestered differently across various species, *Tridax procubems* had the highest carbon storage capacity of (3.85kg), *Laportea aestuans* sequestered carbon at a high rate (3.06kg), *Heteropogon contortus* stocks carbon at the rate 2.99kg and *Sida acuta* being the least sequestered (2.37kg).

Table 1; Biomass, Carbon Stocks and Sequestered Carbon Dioxide Efflux (SCO_2E) Of Herbs

Species	Biomass (KG)	Sequestered (KG)	Carbon SOC	TSC	SCO_2E
Heterpogon contortus	2.26	1.13	1.86	2.99	10.97
Tridax procumbens	3.16	1.58	2.27	3.85	14.13
Sida acuta	1.10	0.55	1.82	2.37	8.69
Laportea aestuans	1.46	0.73	2.33	3.06	11.23
Synedrella nodiflora	0.30	0.15	1.92	2.07	0.56
Cynodon dactylon	1.02	0.51	2.09	2.60	1.87
Axonopus affinis	0.48	0.24	1.44	1.68	0.87
Ipomoea triloba	0.87	0.44	1.98	2.42	1.60

SC= Sequestered carbon, SOC = Soil organic carbon, TSC = Total sequestered carbon, SCO_2E= Sequestered organic carbon efflux

3.2 Biochemical Test

Biochemical test results for the lawn samples are presented in table 2. Among the sixteen (16) bacteria strains identified from eight (8) different samples of lawn plant, six (6) were gram positive cocci and rod formers of different sizes which belong to the species Bacillus, Escherichia coli, *Klebsiella,* Proteus, Staphylococcus, and Streptococcus, respectively. On the other hand, 11 were gram negative short rod and cocci strains that belongs to the species klebsiella (2), Escherichia coli (3), Shigella species (3), Salmonella species (1) and Proteus species (3). The biochemical rests showed that *Sida acuta* contains 3-gram positive short rods of three different species (*Bacillus species, Proteus species, Klebsiella species.* The results also showed that *Heteropogon contortus* contains 2-gram negative rods of different sizes which belongs to the species *Proteus and Escherichia coli* on the other hand, 1 was gram positive short rod that belongs to a single species *Bacillus*. The biochemical test on *Tridax Procumbens* evaluated showed that the sample contain 3-gram positive rods and cocci which belong to the species *Staphylococcus, Proteus species* and *Escherichia coli*. The test also showed that 1 was gram negative short rod strains that belongs to Bacillus species. The *Laportea aestuans species of lawn plants* showed that all 4 microbial species identified were gram positive rod and cocci strains and belong to the following (*Bacillus species, Streptococcus,).* The *Ipomea triloba* plants revealed that the sample contained *3-gram negative rod strains and* the species identified are (*Klebsiella, Escherichia coli*

and Shigella species). *Cynodon dactylon* contains 2-gram positive rods of different sizes which belongs to the species *Bacillus* and *Escherichia coli* on the other hand, 2 were gram negative short and cocci that belongs to a single species *Escherichia coli.* The biochemical test on *Axonopus affinis* sample showed that the sample contain 1-gram positive rod which belong to the species *Bacillus*. The test also showed that 3 were gram negative short rod and cocci strains that belongs to *Proteus* species and *Salmonella* species respectively. The *Synedrella nodiflora* species of lawn plant sample showed two-gram positive rod cocci which belongs to the species, *Bacillus* and proteus respectively. On the other hand, 2-gram negative short rod and cocci strain which belong to a single species *Shigella*

Table 2: Biochemical Test for Identification of Bacterial Species

Samples	Morphology	Gram's reaction	Catalase	Citrate	Urease	Indole	H_2s	Motility	Bacteria isolates
Sida acuta 2 3 4	Rod	+ + +	+ + +	+	+ + +	- - -	-	-	*Bacillus species*
		+	+	- -	+	-	+	+	*Proteus species*
				-			-	+	*Klebsiella species*
							-	-	*Klebsiella species*
Heteropogon contortus 2 4	Rod	-	+ +	- -	-	+	-	+ +	*Escherichia coli*
		+	+ +		+	-	-	+ +	*Bacillus Species*
		- -			+	-			*Proteus species*
					-	+			*Escherichia Coli*
Tridax Procumbens 2 3 4	Cocci	+	+ + +	- - -	+ + +	- - -	- - -	- - -	*Staphyloccocus*
	Rod-shaped	-	+	+	+	-	+	+	*Bascillus species*
	Rod-shaped	+							*Proteus specie s*
	Cocci	+							*Escherichia coli*
Laportea aestuans 1 3 4	Rod-shaped	+	+	-	-	-	-	-	*Bascillus species*
	cocci cocci cocci	+ +	-	- -	- -	- -	- -	- -	*Streptocoocus*
		+	+	-	-	-	-	-	*Bascillus specie*
			-						*Streptocoocus specie*
Ipomea triloba 1 2 3 4	Rod	-	+	-	+	-	-	-	*Klebsiella,*
		-	+	-	+	-	-	-	*Escherichia coli*
		-	+	-	-	+	-	+	*Shigella species*
		-	+	-	-	-	-	+	
Cynodon dactylon 1 2 3 4	Rod,	+	+	+	-	-	-	-	Bacillus Species,
	Cocci	-	+	-	+	+	-	-	Escherichia coli
		-	+	-	+	+	-	-	
		+	+	+	+	+	-	-	
Axonopus afinis 1 2 3 4	Rod,	+	+	-	-	-	-	-	Bacillus Species
	Cocci	-	+	+	-	-	-	-	Salmonella species
		-	+	+	+	+	-	-	Proteus species
		-	+	-	+	+	-	-	Proteus species
Synedrella nodiflora 1 2 3 4	Rod	-	+	-	-	-	-	-	Shigella species
	Rod	+	+	-	-	-	-	+	Bacillus species
	Cocci	-	+	-	-	-	-	-	Shigella species
	Cocci	+	+	-	+	+	-	+	Proteus species

3.5 ANOVA for Carbon Efflux

Table 3 shows the results for the analysis of variation for CO_2 emission from microbial respiration in lawns. Analysis showed that there is no significant difference (p=0.00) in CO_2 emission between lawn species and microbial respiration

In Table 4, the Analysis of variance (ANOVA) for total bacterial and fungal counts in soil showed that there is significant difference at ($P \leq 0.008$) for bacterial species counted. The microbial analysis for total bacterial and fungal counts in the soil analysed and showed that bacterial counts in lawns samples are higher than fungal counts across the four lawn samples.

Table 3: Showing the analysis variance (ANOVA) for carbon dioxide efflux from microbial respiration in 8 weeks.

Tests of Between-Subjects Effects					
Dependent Variable:	**CO2 efflux**				
Source	**Type III Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**
Corrected Model	8691.379[a]	31	280.367	21.628	0.000
Intercept	26170.001	1	26170.001	2018.811	0.000
Species	1237.020	3	412.340	31.809	0.000
Week	2656.681	7	379.526	29.277	0.000
Species * Week	4797.678	21	228.461	17.624	0.000
Error	829.637	64	12.963		
Total	35691.017	96			
Corrected Total	9521.016	95			

Table 4: Showing the Analysis of variance (ANOVA) for total bacterial and fungal counts in soil with significant difference ($P \leq 0.005$)

	Tests of Between-Subjects Effects					
Source	**Type III**	**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Corrected Model	Bacterial count	848.063[a]	3	282.688	8.269	0.008
	Fungal count	3379.500[b]	3	1126.500	13.929	0.002
Intercept	Bacterial count	23100.188	1	23100.188	675.691	0.000
	Fungal count	18723.000	1	18723.000	231.505	0.000
Species	Bacterial count	848.063	3	282.688	8.269	0.008
	Fungal count	3379.500	3	1126.500	13.929	0.002
Error	Bacterial count	273.500	8	34.188		
	Fungal count	647.000	8	80.875		
Total	Bacterial count	24221.750	12			

		Fungal count	22749.500	12
Total	Corrected	Bacterial count	1121.563	11
		Fungal count	4026.500	11

4. DISCUSSIONS

The study found out that well managed lawn herbs sequester more carbon with high stock rate compared to lawn without management practice. The university lawn is well managed but invasive herbs find their way and thus the need for this study, the amount of carbon stored by grasses in studied lawns are low compared to those stored by invasive herbs growing along sides. Results from this finding shows that *Tridax procumbens* had a higher biomass of 3.16kg sequester more carbon (1.58kg) compared to other lawn species like *Heteropogon contortus* with biomass of 2.26kg sequestered 1.13kg carbon, *Sida acuta* with biomass of 1.10kg sequestered 0.55kg carbon, *Laportea aestuans* with biomass of 1.46kg sequestered 0.73kg carbon. Likewise, grass species like *Synedrella nodiflora* with biomass 0.30kg sequestered 0.15kg carbon, *Cynodon dactylon* with biomass of 1.02kg sequestered 0.51kg carbon the highest in the grass category, *Axonopu*s *affinis* with biomass of 0.48kg sequestered 0.24kg carbon which was the lowest and *Ipomoea triloba* with biomass of 0.87kg sequestered 0.44kg. The findings from this study are in line with Beard *et al.*, (2019) who found carbon sequestration rate to be high in well managed and maintained lawn grasses. This study confirms previous finding where the carbon sequestration rate was highest lawns in the university environment. It can then be estimated that lawn herbs and grasses sequestered more carbon

The study found out that CO_2 emission efflux was highest in *Tridax procumbens* and lowest in *Synedrella nodiflora* corresponding to 14.13mg/kg and 0.56 mg/kg, respectively (Table 1). The low CO_2 emission in *Synedrella nodiflora* is due to the microbial population that characterizes it as shown in Table 2 compared to other lawn samples. The study also found out CO_2 emission in different lawn samples across 8 weeks is highest in week 4 and lowest in week 6 respectively. However, the results revealed that there is a significant (p=0.00) difference in carbon emission rate in the species and that lawns 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. Species in the study area emitted carbon through soil microbial. An overview of the result shows soil microbes is key ecosystem process that emits carbon from the soil in the form of carbon dioxide (Lipson, 2005).

The study also found out that bacterial counts in samples are higher than fungal counts across the four lawn samples. This finding agrees with the findings of Janusauskaite *et al.*, (2013) and Silva *et al.*, (2013) who found out that Bacteria, Actinomycetes and Protozoa can tolerate more soil disturbance than the fungi, hence they dominate in the often tilled/worked soil. The study also found out that there is a higher difference in bacterial and fungal counts in *Ipomoea triloba* compared to other lawn samples used for the study. This suggests that there is 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.*, (2015) who found out 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.*, 2022). 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.*, 2013).

The low carbon sequestration rate of *Axonopus affinis* as compared to other lawn herbs and grasses (*Tridax procumbens*, *Heteropogon contortus*, *Sida acuta*, *Laportea aestuans*, *Cynodon dactylon*, *Synedella nodiflora*, and *Ipomoea triloba*) is as a result of the presence of gam negative Proteus, Bacillus and Salmonella bacteria species. The primary role of Proteus bacteria is urease production, they support the breakdown of urea, releasing carbon dioxide as a by-product. Salmonella utilizes available carbon sources like glucose for energy and growth; their presence primarily indicates the faecal contamination in the soil. Their primary roles in the soil are affected by the presence of organic matter, soil type, and the presence of other microbes in the soil. Salmonella relies on relies on carbon metabolism to adapt to its environments, they exhibit metabolic flexibility, Salmonella utilizes carbon sources to produce extracellular polysaccharides, which it uses for biofilm formation, they also, produce a one-carbon metabolism for the synthesis of essential biomolecules such as glycine, methionine, and purines. a process regulated by cyclic di-GMP. Bacillus bacterial species share a mutualistic relationship with plants by improving the decomposition of organic matter, while converting complex carbon compounds into simpler forms and contributing to the formation of humus. Their presence in the soil is an indicator for soil fertility and carbon sequestration. This agrees with the findings of Zhang *et al*. (2021) who found out that Bacillus mucilaginous produces carbonic anhydrase that first captures the atmospheric CO2 and then fixes the atmospheric CO2 through bacterial metabolism. In this case the low carbon sequestration observed in *Axonopus affinis* suggests that even though Bacillus was present, the presence of Salmonella in the soil impeded the rate of respiration and sequestration of carbon by host plant.

5. CONCLUSIONS

Analysis of the vegetation cover within the study area revealed that these grasses and herbs like every other terrestrial carbon sink can serve as a good sequester. Also, the Carbon emission potential analysed in the study showed that *plants like Ipmoea triloba* emits lower carbon with a significant ($P<0.05$) difference and this was attributed to the microbial counts ascertained also in the course of the study. Bacterial and fungal population count were significantly ($P\leq0.05$) 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 herbs and grasses have great potentials as carbon sequestered in Joseph Sarwan Tarka University Makurdi.

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