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Inventory and Assessment of Carbon Storage Capacity of species of Palms in Universiti Tun Husein Onn Malaysia, Main Campus, Batu Pahat, Johor Malaysia

Yunusa Audu[1*2,] and Alona Cuevas Lintoc[1]
[1]Department of Technology and Natural Resources, Faculty of Applied Sciences and Technology, Universiti Tun Husein Onn Malaysia, Pagoh Campus, Pagoh Educational Hub, Km.1 Jalan Panchor,84600 Muar, Johor, Malaysia
[2]Department of Biological Science, Faculty of Natural Science, Ibrahim Badamasi Babangida University Lapai, Niger State, Nigeria

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Abstract: Carbon dioxide constitutes about 0.04% of greenhouse gases in the atmosphere. Its concentration in the atmosphere influences the climate pattern of the world. The unceasing rise above the ambient level leads to global warming. The increase in CO_2 release in UTHM (238.8964 ha), was due to the increasing number of vehicles, and other greenhouse gases released from building structures, facilities and discharges from neighbouring industries. A study was conducted on eleven most common species of palms for their capacity to sequester CO_2 from the atmosphere. The Estimation of carbon storage of the palms plants was obtained by the assessments of the above standing biomass and their photosynthetic capacity. Results show that *R. regia* has the highest CO_2 absorption capacity of 10.61 µmol m^{-2} s^{-1}, followed by *O. tigillarium* with 7.26 µmol m^{-2} s^{-1}, and *W. bifurcata* with 6.83µmol m^{-2} s^{-1}. *E. guineensis* has the highest aboveground biomass accumulation of 0.09 kg, followed by *R. regia* with 0.05 kg. The total standing biomass captured by all the palms species is 53.00 kg of CO_2. Hence, species of palms in UTHM have the capacities to absorb CO_2 from the atmosphere, thus contributing in reducing-the effects of global warming.

Keywords: Carbon dioxide sequestration, tropical vegetation, global warming, climate change, biomass.

1. Introduction

University Tun Hussein Onn Malaysia is located at Parit Raja Batu Pahat in the state of Johor Malaysia, 1.8531° N, 103.0864°. It has a total land area of 238.8964ha; the institution is equipped with standard buildings, classrooms, standard laboratories with modern equipment used for standard experiment and transport facilities for the smooth running of the institution. A record from the office of the assistant security officer (UTHM) shows that there are 11,403 registered cars as of 21st February 2018. The presence of higher number of vehicles result to increase in the release of more CO_2 and other green gases from within the university lead to a higher emission of gases into the university, and this ultimately will affect the local climate. Report from UTHM carbon emission by [1] indicates that more than 20,000 tons of carbon are emitted into the environment every year. The global environmental warming is increasing annually. The continuous increase of CO_2 in our atmosphere observed from 280 parts per million (ppm) in 1850 up to 394 ppm in 2012 was due to the arithmetic accumulation of CO_2 in our environment [2]. This phenomenon continued to as much as 400 ppm concentration of CO_2 in the environment doubling as large as compared to the last 8000yrs [3]. The United Nation Framework Conference on Climate Change (UNFCCC), at its 16th Conference of the Paris held in 2010, parties to the UNFCCC agreed that future global warming should not exceed 2°C relative to the pre-industrial temperature level as a result of the accumulation of CO_2 in the environment. This resulted in the formulation of the Kyoto Protocol (2008-2012), which was then followed by the Paris Agreement (2017-2022).

2. Roles of species of palms plants in carbon storage capacity

Continuous accumulation of CO_2 in the environment caused an increase in the level of carbon in the atmosphere, and this disrupts the global carbon cycle. However, the effect is checked as plants function naturally to sequester and store the carbon into biomass as they grow. [4] estimated the total carbon per unit area of oil palms across age groups for two benchmark areas of West Africa as 14.75 tons C ha^{-1} and 14.94 tons C ha^{-1} respectively. The corresponding dry biomasses were 29.5 C ha^{-1} and 29.88 C ha^{-1} respectively. The ages of the oil

*Corresponding author: abduldaudu@yahoo.co.uk

palms were between one and five years across the benchmark areas. The mean rate of accumulation of carbon was 2.95 tons C ha^{-1} yr^{-1} in benchmark area one Eglime and 2.99 tons C ha^{-1} yr^{-1} in benchmark area two Zouzouvou, both located in the Republic of Benin in West Africa. The total aboveground biomass accumulation of carbon in oil palm biomass was estimated to about five tons of carbon ha^{-1} yr^{-1} [5]. The aboveground time-averaged carbon stock of oil palm plantation is similar between the two estates with 38.8 tons ha^{-1} and 39.2 tons ha^{-1} respectively for site one Sumatra estate and site two Kalimantan estate, with 25 years planting cycle. [6] observed low (<1 Mg ha^{-1} $year^{-1}$) rates of C accumulation were observed in coconut (*Cocos nucifera L.*) plantations, coconut + banana, bush fallow, and grasslands. Agroforestry systems like home gardens and corn (*Zea mays* L.) + Timber and fruit trees can have both high rates of C accumulation and high tree diversity, implying the synergy between C accumulation and maintenance of tree diversity. In a similar study, [7] estimated total highest organic carbon in *Cocos nucifera* 12.48 Mg ha^{-1}, followed by *Areca catechu* 4.20 Mg ha^{-1}, *Borassus flabellifer* 3.02 Mg $ha^{-1}$and *Phoenix sylvestris* 0.59 Mg ha^{-1}. The total amount of organic carbon stored by palm trees in homestead areas was 20.28 metric ton/ hector in the study area. The study revealed that palm trees of homestead forest accumulate a good amount of biomass and is a good sinker of organic carbon from the atmosphere. Proper management of palm trees will help to improve the local, national and international community through carbon sequestration. [8] reported biomass accumulation of *Wodyetia bifurcata* 69.95 kg $tree^{-1}$, *Cocos nucifera* 124.81 kg $tree^{-1}$, *Roystonea oleracea* 105.84, *Ravenala madagascariensis* 22.35 kg $tree^{-1}$, *Elaeis guineensis* 130.54 kg $tree^{-1}$, *Licuala grandis* 12.91, *Bismarckia nobilis* 80.38 kg $tree^{-1}$, *Latania lontaroide*s 81.89 kg $tree^{-1}$, *Phoenix Roebelen*i 14.05 kg $tree^{-1}$, *Phoenix dactylifera* 159.00 kg $tree^{-1}$, *Coccothrinax argentata* 97.34 kg $tree^{-1}$, *Areca catechu* 44.00 kg $tree^{-1}$ and *Adonidia merrilli* 33.49 kg $tree^{-1}$, in the role of vegetation in the CO_2 flux from a tropical urban neighbourhood.

3. Methods

The study was carried out at Universiti Tun Husein Onn Malaysia (UTHM) main campus with coordinate 1.8531° N, 103.0864°. The university has 1,059 academic staff, non-academic/staff 1,278, and a total number of 16,226 students. There are 11,403 registered cars as of 21st February 2018. The overall area cover of the campus is 238.896 hectares. Out of this figure, 152.667 hectares are developed, while the remaining area stands as undeveloped/reserved. The species of palms within the UTHM main campus were surveyed and identified as described by [9]. Significant numbers, varieties and well-preserved samples collected were deposited at UTHM botany herbarium for research references. The species were studied for quantification of CO_2 sequestration through the measurement of CO_2 absorption capacity. Li-6400 Portable Photosynthesis System (LI-COR Inc., USA) was used to measure the CO_2 photosynthetic assimilation rate (PAR), which is automatic and has an autonomous control leaf chamber CO_2, H_2O, temperature, and light. However, to have a good estimation of CO_2 and to avoid uncertainty during measurement, the air flow was set at 500 µmol, CO_2 at 360 µmol, block temperature 300 ^oC and PAR (Photosynthetic active radiation) light at 1000nm. The biomass accumulation of carbon by the species was estimated through the below procedure. Measurement of diameter at breast height (DBH) and Plant height). A non-destructive method was used to estimate the biomass of palms species. The estimation was based on the diameter at breast height (DBH) and the height. DBH was calculated by measuring palms diameter at Breast Height (BH), approximately 1.3 meters above the ground. The diameters of were measured directly by the measuring tape. The heights were measured by the used of measuring pole of height 5m called staff and a Theodolite instrument (Total Station). 2. The Below Ground Biomass (BGB) includes all biomass of live roots excluding fine roots less than 2 mm diameter. The below-ground biomass was calculated by multiplying AGB by 0.26 factors as the root: shoot ratio. BGB is calculated by the following formula. BGB (Kg/tree) = AGB (Kg/tree) or (ton/tree) x 0.26 [10]. However, Leaves carbon content (LCC) was obtained by the leaf ashing method as described by Thomas R. Peacock [12], and the resulting ash content was used to determine the leaves carbon content of the study plants.

4. Results and Discussion

Palms species except for Oil palm and Cocus are planted in our environment for beatification, but tropical trees including palms have 70 to 100 yrs or more lifespan and are characterized by slow growth but with storage of large quantities of carbon in their vegetative component [13]. However, the species of palms in UTHM are not the exception; they play a role in the absorption of CO_2 emitted thereby function to mitigate the effect of localized global warming. From the eleven (11) most common species of palms used in the study, there are more introduced species than the native; no endangered and no species are in extinction. There are about tree thousand and seventy individual species of palms (3070). *Livistona chinensis* has the significant number (544), while *Onscosperma tigillarium* has the lowest number (43) shown in the Table 1.

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Table 1. A checklist of species Palms showing introduced, native, endangered, extinction and their total number.

No	Palm species	Introduced	Native	Endangered	Total Number	Section			
						A	B	C	D
1	*Livistona chinensis*	√			544		√		
2	*Ptychosperma macarthurii*	√			534		√		
3	*Cyrtostachys renda*		√		427		√		
4	*Rhaphis excelsa*	√			416			√	
5	*Wodyetia bifurcata*	√			361		√		
6	*Cocos nucifera*		√		235		√		
7	*Elaeis guineensis*	√			179	√			
8	*Roystonea regia*	√			163			√	
9	*Ravenala madagascariensis*	√			105				√
10	*Licuala grandis*		√		66	√			
11	*Onscosperma tigillarium*		√		43		√		
Total number					**3,070**				

*Corresponding author: abduldaudu@yahoo.co.uk

Table 2: Parameters of common palms to quantify biomass accumulation with AGB and BGB, and CO_2 absorption capacity

No	Species Scientific name	No. of individuals	CO_2 Assimilation (µ mol/m2/sec)	LAI (cm^2)	STC	S/F	LCC (kg)	TSB (kg)
1	*L. chinensis*	544	4.34 ± 0.61	1.73 ± 0.59	5.00 ± 1.00	0.05	0.02	0.02±0.02
2	*P. macarthurii*	534	5.78 ± 1.53	0.34 ± 0.09	28.00 ± 6.11	0.01	0.02	0.02±0.02
3	*C. renda*	427	3.80 ± 0.98	1.83 ± 0.40	8.00 ± 2.89	0.01	0.02	0.02±0.02
4	*R. excelsa*	416	0.31 ± 0.22	0.42 ± 0.12	2.00 ± 0.00	0.01	0.01	0.01±0.03
5	*W. bifurcata*	361	6.83 ± 0.99	0.80 ± 0.08	19.00 ± 8.00	0.04	0.01	0.01±0.02
6	*C. nucifera*	235	3.28 ± 0.13	1.24 ± 1.04	5.00 ± 1.00	0.01	0.01	0.02±0.02
7	*E. guineensis*	179	6.14 ± 2.49	2.34 ± 0.58	29.00 ± 3.79	1.33	0.02	0.09±0.01
8	*R. regia*	163	10.61 ± 1.62	1.06 ± 0.24	29.00 ± 8.74	0.16	0.01	0.05±0.01
9	*R.madagascariensis*	105	3.79 ± 0.37	7.13 ± 5.91	22.00 ± 5.57	0.04	0.02	0.02±0.02
10	*L. grandis*	66	1.22 ± 0.68	8.06 ± 0.72	17.00 ± 8.96	0.02	0.016	0.02±0.01
11	*O. tigillarium*	43	7.26 ± 0.63	0.31 ± 0.26	23.00 ± 5.51	0.01	0.02	0.02±0.02
Total number		**3,073**	**53.00**					**0.30**

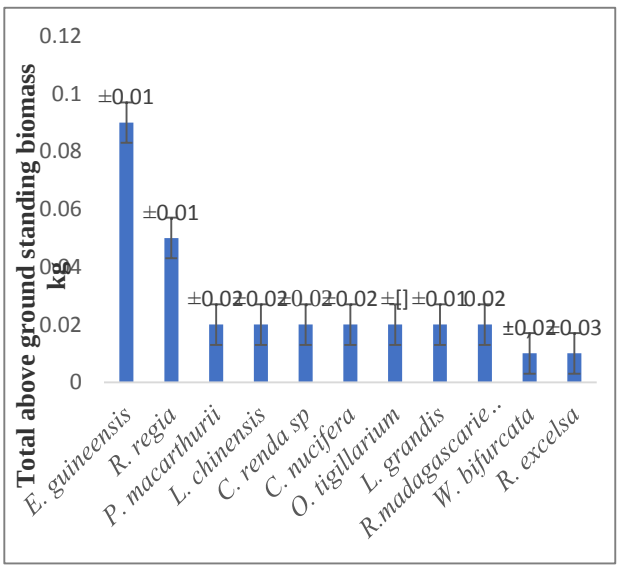

Figure 1: Graph showing total aboveground Standing biomass

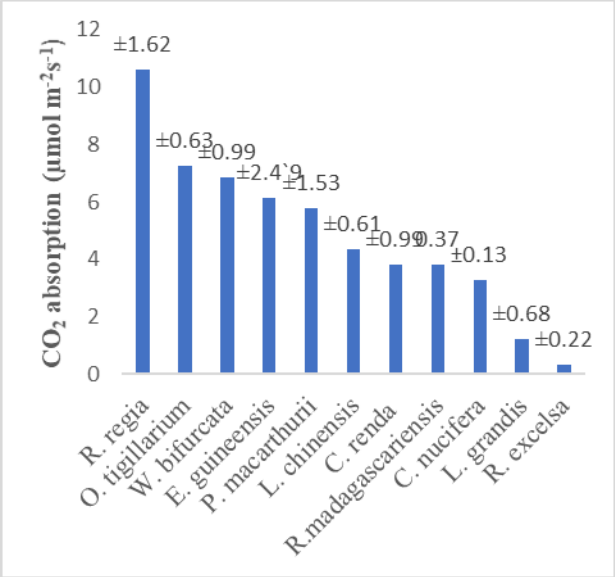

Figure 2: Graph Showing CO_2 absorption

5. Summary

Species of palms that beautify our environment also function significantly in the reduction of atmospheric carbon dioxide level. It can be concluded from the result obtained that CO_2 absorption and sequestration determined for eleven most common species of palms shows that, E. *guineensis* and *R. regia* has the highest and better CO_2 sequestration rate. *R. regia* was found to have the highest CO_2 absorption. Therefore *E. guineensis* and *R. regia* sequestered CO_2 better when compared to other species and therefore could be recommended for the planting of more species in the university campus for better sequestration of CO_2 from the atmosphere.

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