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Research paper

Assessment and Potential of Carbon Storage Capacity of Species of Herbaceous Plants in Universiti Tun Hussein Onn Malaysia, Main Campus, Batu Pahat, Johor Malaysia

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Abstract

Carbon dioxide CO_2 is an important trace gas in earth's atmosphere. It is a greenhouse gas that plays a vital role in regulating the earth's surface temperature through the greenhouse effect. Increase beyond the ambient concentration leads to global warming. Increase in CO_2 discharge in UTHM (238.9 ha), due to increase in a number of vehicles; other greenhouse gases released from building amenities and dis-charges from neighbouring industries appeals for attention. Study was conducted on seven common species of herbaceous plants for their capacity in sequestering CO_2. Estimation of carbon storage of herbaceous plants was obtained by the assessments of the above-ground standing biomass and their photosynthetic capacity. *Musa* sp has the highest CO_2 absorption of 12.2µmol m^{-2} s^{-1}, followed by *Heliconia. psittacorum* (10.63µmol m^{-2} s^{-1}). *Euphorbia tithymaloides* and *Costus spicatus* has the lowest absorption with 3.63 and 3.76 µmol m^{-2} s^{-1} respectively. *Calathea lutea* and *Hymenocallis latifolia* shared the highest biomass accumulation of 0.04 kg. These were followed *by E. tithymaloides* and *Alpinia purpurata* with 0.02 kg. The least biomass of 0.01 kg was accumulated by *H. psittacorum* and *C. spicatus*. The total standing biomass captured by all the species of herbaceous plants is 0.13 kg. Therefore, species of herbaceous plants in UTHM have the potentials to absorb an adequate amount of CO_2 from the atmosphere thereby contributing to reducing-the effects of localized global warming.

Keywords: *Absorption of Carbon; Carbon Dioxide; Global Warming; Greenhouse Effect; Herbaceous Plants.*

1. Introduction

Urban forests and trees are receiving added significance in developing countries of the world. They remain vital tools in urban biodiversity and play a role in reducing worldwide warming. Universiti Tun Hussein Onn Malaysia UTHM is an institution of higher learning located at Parit Raja, Batu Pahat in the state of Johor, Malaysia with coordinates 1.8531° N, 103.0864°, occupying area of 238.8964 ha. The University is furnished with state of the art research facilities, Professional human resources and coordinated transport system aimed at creating conducive leaning environment**.**

There are about 11,403 registered cars as at 21/2/2018 (UTHM, 2018). The higher number of vehicles running within the campus causes the increase in the discharge of additional CO_2 and other green gases from within the campus; this leads to a higher emission of gases into the University, which will eventually influence the local microclimate. Report from UTHM carbon emission (1) shows that more than 20,000 tons of carbon are emitted into the environment every year.

The worldwide environmental warming is increasing yearly. The continuous increase of CO_2 in the atmosphere that as witnessed from 280 parts per million (ppm) in 1850 up to 394 ppm in 2012 and recently 410.76 is as a result of continues accumulation of CO_2 in the environment (10). The occurrence persisted to as much as 400 ppm of CO_2 concentration in the surroundings doubling as large as it is compared to the last 1800yrs (6).

The United Nation Framework Conference on Climate Change (UNFCCC), at its 16th Conference of the Paris agreement held in 2010, parties agreed that future global warming should not exceed 2°C and limit temperature to 1.5 °C compared to the pre-industrial temperature level as a result of the accumulation of CO_2 in the environment (8).

2. Roles of Species of Herbaceous Plants in Carbon Storage Capacity

The constant increase of CO_2 in the environment triggers an increase in the amount of carbon in the atmosphere; this ultimately interrupts the worldwide carbon cycle. Nevertheless, the effect is frequently reduced as plants function naturally to accumulate and store the carbon into biomass on maturity.

A reported by (9) postulated the average aboveground standing stocks of carbon range from 16 to 36 Mg ha^{-1}, whereas small home gardens have greater carbon stocks on a unit area basis than huge and medium-sized ones. This indicates the potential for carbon sequestration and agro-biodiversity preservation, mainly by small household gardens.

A report by (2) indicated the biomass accumulation of Abaca (Musa textilis Nee), fresh weight of the pseudostem of the sample plants to range from 1.6 kg to 35.3 kg while that of the leaf tissues ranged from 0.7 kg to 6.4 kg. These values, when summed-up, gave the above-ground fresh weight that ranged from 2.3 kg to 41.7 kg. Moisture contents are from 78.5% and 90.9%. Likewise, pseudostem dry weight range from 0.1 kg – 3.8 kg while the leaf dry weight alternate from 0.10 kg – 1.4 kg.
Thus, the total above-ground dry weight ranged from 0.3 kg to 5.0 kg only for all the collected samples. It is reported that the bulk of the above-ground biomass was mainly attributed to the high biomass content of the pseudostem tissues and not of the leaf tissues.
A report by (3) indicated that *Saccharum officinarum* had maximum carbon mitigation with 3.3 ton of carbon ha^{-1} which is followed by *Oryza sativa* with 0.6 ton of carbon ha^{-1} and *Musa* paradisiacal 0.3 ton of carbon ha-1 in annual crops. However, agroforestry land use systems viz. *O. sativa*, *S. officinarum* and *M.* paradisiacal boundary plantation contributed 8.0, 5.4 and 5 ton of carbon ha^{-1} respectively, in non-destructive approach for biomass estimation and carbon mitigation in different land use systems.

Table 1: A checklist of species of herbaceous plants showing introduced, native and their total number

Serial/Number	Species of plant	Introduced	Native	Total NO
1	*Alpinia pur-purata*	√		1437
2	*Calathea lutea*	√		1827
3	*Costus spicatus*		√	14,648
4	*Euphorbia tithymaloides*	√		153
5	*Heliconia psittacorum*	√		78
6	*Hymenocallis latifolia*	√		2632
7	*Musa* sp	√		356
T/NO				21,172

3. Methodology

The study was carried out at UTHM main campus with coordinate 1.8531° N, 103.0864, with 11,403 cars recorded as at 21/2/2018. The overall area covered by the campus is 238.9 hectares out of which 152.7 acres are developed, and the remaining space is reserved for future development. The species of herbaceous plants within UTHM main campus were surveyed and identified as described by (7). Substantial numbers of varieties and well-preserved samples collected were deposited at UTHM repository for further research reference.
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 Nebraska Inc., USA) was used to measure the CO_2 photosynthetic assimilation rate (PASR).
For a reasonable estimation of CO_2 and to avoid uncertainty during measurement, the Li-6400 air flow was set at 500 µmol, CO_2 at 360 µmol, block temperature 300oC and PAR (Photosynthetic active radiation) light at 1000µmol/m^{-2}/s^{-2}. Data was analysis using one-way ANOVA, t-Test, and Levene test for homogeneity of variance. For post-hoc comparison of means between different levels of the photon, Turkey's HSD test was used. All the statistical analyses were conducted using Excel and IBM SPSS Statistics 22. Biomass accumulation of carbon by the species was estimated through the use of Excel to compare the means of the species. The below procedure was followed to determine the biomass of the species.

3.1. Measurement of Plant height and diameter

A non-destructive method was used to estimate the biomass of herbaceous species. The diameter and height of plants were measured directly by the measuring tape. The measurement of diameter was made at about 5.0 cm from ground level.

3.2. Total Standing Biomass (TSB) of herbaceous plants.

The equation Y= 0.11574 + 0 .9449D2H by (4) was used to estimate the biomass of herbaceous plants. Where D is diameter at breast height and H is the height of the plants.

3.3. Below ground biomass (BGB) and leaf carbon con tent determination

The Below Ground Biomass (BGB) includes all biomass of live roots excluding fine roots less than 2 mm in diameter. The below-ground biomass was calculated by multiplying total standing biomass (TSB) by 0.26 factors as the root: shoot ratio (TSB Kg/ Herbaceous plants x 0.26 (5).
However, leaves carbon content (LCC) was obtained by the leaf ashing method as described by (11) and the resulting ash content was used to determine the leaves carbon content (LCC) of the studied plants.

Species of herbaceous plants play a role in CO_2 absorption thereby in their capacity function to reduce the effect of localized global warming.

4. Result

There are twenty-two thousand one hundred and seventy-two individual species of herbaceous plants (Table 1 above). *C. spicatus* has the largest number of species with 14,689, while *H. psittacorum* has the lowest number of 78. The result in Table 2 indicates that *C. lutea* and *H. latifolia* had the highest biomass accumulation of 0.04 kg, which was the highest when compared to other species of herbaceous plants that are comparable.
The total standing biomass captured by all the species is 0.1 kg of CO_2 (Table 2). The CO_2 absorption of the species studied is shown in Table 2, Figure 2. *Musa* sp has the highest CO_2 absorption of 12.2 µmol m^{-2} s^{-1}, followed by *H. psittacorum* with 10.6 µmol m^{-2} s^{-1} and *A. purpurata* with 8.9 µmol m^{-2} s^{-1}. *E. tithymaloides* and *C. spicatus* had the lowest absorption of 3.6 and 3.8 µmol m^{-2} s^{-1} respectively. However, the overall total CO_2 absorption for all the species is 52.1 µmol m^{-2} s^{-1}(Table2).

Table 2: Showing the quantity of biomass accumulation of common herbaceous plants with CO_2 absorption capacity. S/F-Species Factor, TSB-Total Standing Biomass and LCC-Leaf Carbon Content.

Serial/Number	Species Scientific name	Height	Diameter	Number of species	CO_2 Absorption (µ mole/m^{-2}/s^{-1})	S/F	LCC (kg)	TSB (kg)
1	*H. psittacorum*	12.87	0.18	78	10.6 ± 1.05	0.2	0.01	0.01
2	*E. tithymaloides*	11.50	0.11	153	4.5 ± 4.81	0.2	0.02	0.01
3	*A. purpurata*	6.04	0.20	1437	8.9 ± 1.04	0.2	0.01	0.01
4	*Musa* sp	2.46	0.11	356	12.2 ± 0.46	0.01	0.01	0.01

5	*C. lutea*	9.0	0.18	1827	7.2 ± 2.11	0.2	0.04	0.04
6	*H. latifolia*	8.67	0.8	2632	4.9 ± 1.65	0.2	0.07	0.04
7	*C. spicatus*	7.22	0.2	14689	3.8 ± 0.77	0.2	0.01	0.01
T/NO				21,172	52.1			0.13

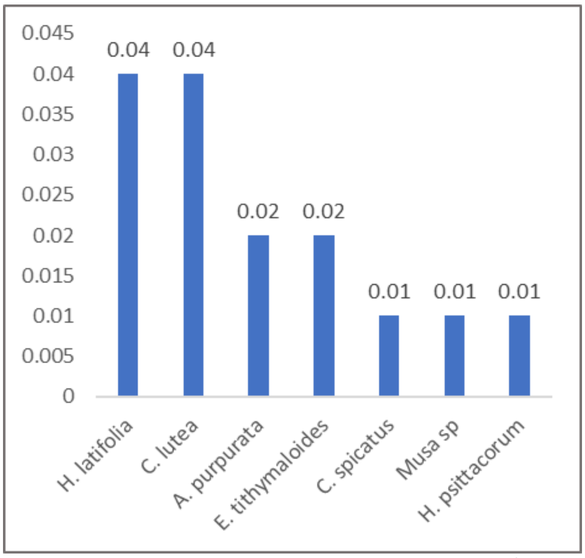

Fig. 1: Graph showing total standing biomass accumulation of her herbaceous plants

However, species of herbaceous plants in our environment play a role in the reduction of atmospheric carbon dioxide level. Even though their accumulation of carbon is not in tons, they still store a reasonable quantity. From the result gotten, it could be concluded that CO_2 absorption and sequestration determined for common herbaceous species shows that, *C. lutea* and *H. latifolia* has a higher CO_2 sequestration rate of 0.04 kg than the other species with lower sequestration rate. *Musa* sp was found to have the highest CO_2 absorption of 12.2 μmol $m^{-2}s^{-1}$ when compared with other species studied.

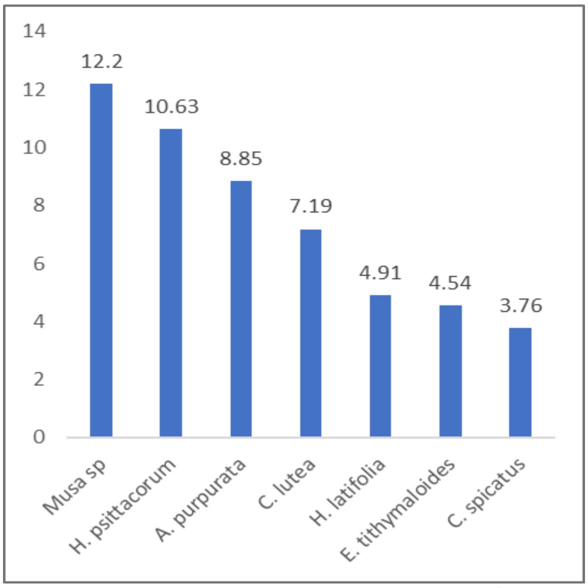

Fig. 2: CO_2 Graph showing absorption by species of herbaceous plants

5. Conclusion

Total biomass accumulation and CO_2 sequestered by all the herbaceous plants was 0.13 kg and 56.2 μmol $m^{-2}s^{-1}$. Therefore, species of herbaceous plants like *Musa* sp, *C. lutea* and *H. latifolia* that sequestered CO_2 better when compared to other species could be recommended for planting on the university campus for better sequestration and assimilation of carbon dioxide from the atmosphere.

References

[1] Abddullah, DMKB (2017) Carbon Emission Report University Tun Hussien Onn Malaysia: Universiti Tun Hussien Onn Malaysia.: Carbon Emission Report Unit.

[2] Armecin R & Coseco W (2012), Abaca (Musa textilis Nee). Allometry for above-ground biomass and fibre production. *Biomass and Bioenergy* 46, 181-189.

[3] Bhalawe S, Jadeja D, Tandel M, Gayakvad P, Parmar M, Prajapati V, & Behera L (2015), Non-Destructive Approach for Biomass Estimation and Carbon Mitigation in Different Land Use Systems. *Trends in Biosciences* 8(15), 3785-3790.

[4] Elliott KJ & Clinton BD (1993), Equations for estimating biomass of herbaceous and woody vegetation in early-successional. Southern Appalachian pine-hardwood. Forests 365: US Department. of Agriculture and Forest Service. South-eastern Forest Experiment Station.

[5] Gedefaw M, Soromessa T & Belliethathan S (2014), Forest carbon stocks in woody plants of Tara Gedam forest: Implication for climate change mitigation. *Science, Technology and Arts Research Journal* 3(1), 101-107.

[6] Gore A (2014), The Turning Point: New Hope for the Climate. Rolling Stone.

[7] Janine EV, Marinda LF, Shirley JS & Marthina M (2004), The Southern African Herbarium User Manual.

[8] Joeri R, Michel DE, Niklas H, Taryn F, Hanna F, Harald W, Roberto S, Fu S, Keywan R & Malte M (2016), Paris Agreement climate proposals need a boost to keep warming well below 2 °C. *Nature* (534), 631–639.

[9] Kumar BM (2011), Species richness and aboveground carbon stocks in the home gardens of central Kerala India. *Agriculture, Ecosystems & Environment* 140(3), 430-440.

[10] NOAA (2012) & Rajput SS (1985) National Oceanic and Atmospheric Administration. *Journal of Timber Development Association of India* 31(3), 12-41.

[11] Peacock TR (1992), The preparation of plant material and determination of weight per cent ash. US Dept. of the Interior, Geological Survey.