SindhUniv. Res. Jour. (Sci. Ser.) Vol. 51 (01) 91- 96 (2019)

http://doi.org/10.26692/sujo/2019.01.17

SINDHUNIVERSITYRESEARCH JOURNAL (SCIENCE SERIES)

Comparative Study of Sequestered Carbon Stock of Different Species at Sindh Madressatul Islam University Karachi, Sindh, Pakistan

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Received 16thAugust 2018 and Revised 09thJanuary 2019

Abstract: Global warming due to increased concentration of greenhouse gases causing climate changes throughout world. Best option to control greenhouse gases, other than the reducing fossilfuel burning, is to plant maximum trees. Trees consume huge amount of carbon as their body growth. This consumption or trapping of carbon is termed as carbon sequestration. Different tree species have different rate to remove and store carbon dioxide from atmosphere. The carbon sequestration rates also depend over regional climate, management practice, topography and texture of soil as well. Biomass accumulation and carbon sequestration comparative studyfrom two different tree species was conducted at the premises area of Sindh Madressatul Islam University Karachi, Sindh, Pakistan by using non harvest methods. This method provides exact measurement of biomass accumulation and carbon removal by sequestration from tropospheric atmosphere layer.Present study reveals that the results of plant height, tree bole diameter at breast level (DBH), above ground biomass (AGB), below ground biomass (BGB), Biomass and carbon sequestration of plant Azardirachta indica were found higher (890 cm, 26.43cm, 298.35kg, 77.57kg, 375.93kg and 187.96 kg) as compared with the results of Conocarpus erectus (796.5cm, 12.10cm, 279.15 kg, 72.57 kg, 351.73kg and 175.86kg) trees.It is suggested that in order to get more carbon sequestrated through tree plantation, preference should always be given Azardirachta indica as compared Conocarpus erectus. This study helps to understand the potential of carbon sequestration of Conocarpus erectus and Azardirachtaindica while planting in urban areas.

Keywords: Carbon sequestration, Carbon dioxide, global warming, Biomass accumulation

1. INTRODUCTION

Climate change phenomenon has occurred due to direct or indirect anthropogenic activities.The composition of the global atmosphere is changing at alarming rate.The pollution that arises from industrial progress since past three centuries, contributing greenhouse gases(GHGs) as CO_2, CH_4, N_2O, CFCs etc, which have the ability to absorb the infrared light, causing warming of our earth atmosphere (IPCC 2007, Montagnini and Nair (2004), Ajani and Shams 2016). GHGs once produced, remain trapped in the atmosphere for hundreds of years. The increased average global temperature including land and surface is 0.85 °C during the period 1880 to 2012 (IPCC 2014). Average global ocean warming till upper 75 meters has reached by 0.11°C per decade recorded during the period from 1971 till 2010, within two decades (1901–2010), global mean sea level rise has been observed to 0.19 m(IPCC 2014).Carbon dioxide is major source that causes global warming among rest of the greenhouse gases, due to their increased concentration in atmospheric (Florides and Christodoulides, 2009). Anthropogenic activities like deforestation, agriculture and livestock production, combustion of fossil fuels have caused tremendous increase in global warming. Since the industrial revolution it has been observed that average concentration of carbon dioxide has increased from 280 ppm to 354 ppm till 1190 and was observed 400 ppm in 2015 (IPCC 2007, Kiran and Kinnary (2011), Chavan and Rasal (2011), Weber (2013), Ajani and Shams 2016), while presently according NASA reports tillmay 2018, it has reached 408ppm in the atmosphere.Increases carbon concentration in atmosphere is the only issue concerned with the very survival of life on earth, requires different preventive and remedial measures. Along withso many preventive carbon reduction methods, best efficient and cost-effective way out, for reducing carbon from atmosphere, is to seize or trap the carbon dioxide intotrees from surrounding atmosphere, as the trees having natural inbuilt capacity to consume carbon (IPCC 2007; Chavan and Rasal (2010), Seamans (2013), Cilliers, *et, al.* 2013). It is the reason forests are termed as natural carbon sinks. Tree plantation in urban areas, including houses,road sides, office buildings etc., gives a lot of ecological and environmental services (Ajani and Shams 2016). A tree in the urban areas have been very beneficial to removethe prevailing carbon dioxide and incorporating as biomass in their body parts like leaves, flowers, fruits, stems and roots through the photosynthesis process.Non harvest method studies for biomass and carbon sequestrations have been conducted across the world (Ajani and Shams 2016). Literature indicates so a many recent

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examples as it was estimated thatfrom 2002 to 2008 nearly 54,630 tonnes of carbon was found sequestrated when near about 115,200 indigenous trees were plantedonly in the South African city Tshwane (Stoffberg *et. al.* 2010).

Within the boundary walls of Sindh Madressatul Islam University there are so a many plant species planted. Only two plant species were selected for comparative studies. This study included total 20 trees of both species Azadirachta indica and Conocarpuserectus. In order to examine carbon stock and carbon dioxide sequestration potential of both species and then obtaining a comparative data, tree samples were randomly selected from the SMIU campus.Azadirachta indica is very commonly planted tree in Sindh throughout centuries as it is indigenous tree of sub-continent South Asia, belonging to the family Meliaceae, remains ever green, producing very conducive environment.Locally known as Neem tree in Sindh, isalso widely planted in rural and urban areas of Pakistan. Conocarpus erectus belongs to family Combretaceae, native treeof America, having best capacity to be grown in brackish water along shorelines as well as over saline soils with special capacity to survive heat and drought.

Within nearly past two decades, Conocarpus erectus has been widely introduced in Pakistan as it has best growing capacity. Basically Conocarpus erectus is a shrub but due to best adaptation capabilities its height, as literature indicates, has gone 20 to 40 meters long. Due to extraordinary capacity for quick growth in worst climatic conditions as growing in drought conditions, salineand sodic soils, as well as in heat and water stress conditions,Conocarpus erectus is widely planted throughout Sindh.Specially in Karachi and Hyderabad this species is found most dominant one, planted as ornamental purposes.

Study area

Sindh Madressatul Islam University Karachi, Sindh, Pakistan.

Sindh Madressatul Islam University is a one of the oldest institutions in South Asia. The Founder of Pakistan, Quaid-e-Azam Mohammad Ali Jinnah, studied at this institution for about four and a half years from 1887-92. Its campus is located in the commercial hub of Karachi, near I.I. Chundrigar Road in vicinity of Habib Bank Plaza and MCB Tower. It is spread over more than eight acres of land and comprises some of the most beautiful colonial era buildings designed by architect James Strachan in 1880s.TheKarachi has been located in aridand hot desert climatic region, rich with humid coastal winds(Ajani and Shams 2016).This mega city with the population more than 2 crores, hardly receive 250 mm annual average precipitation per year.Geographically this city is also famous for high southwestern winds and high relative humidity during summer times. But due to exceeding climate change scenario generally and fastly depletion of vegetative areas and trees, have also increased heat wave impacts in the city.

2. METHODOLOGY

A) Calculating the tree height and bole diameter

The biomass of different two species Azadirachta indica and Conocarpus erectus was calculated after taking their heights and diameters at breast height (DBH). The treeheight was taken by measuring tree shadow multiplied by your height and divided by your shadow (Kotte*et al.,* 2006, Schroeder 1992, Ajani and Shams 2016).Tree height=Tree shadow x your height/your shadow.Diameters at breast height (DBH) are measuring of circumference of tree bole using a measuring tape or at breast height.We can also use 1.3-meter height from the ground using a simple same measuring tape instead of breast height.

B) Biomass calculation:

For Biomass calculation, the most appropriate method is non-destructive method (Schroeder, 1992). Instead chopping oftreesthismethodis basedover basic

measurements and their calculations within equations.AGB (above ground biomass) of tree parts like a leaf, flowers, fruits, shoots and branches, is calculatedis as under.AGB (Kg) = Volume of tree (V) x Wood density (Kg/m³).Where V =π r²H,V= Volume of tree, r = Radius of tree bole at breast height, H = Height of tree(Ajani and Shams 2016).

The wood densities of two selected species Conocarpus erectus and Azadirachta indica were taken from the Global Wood Density Database and were found to be 690 Kg/m³ and 660 Kg/m³ respectively(Cairns *et al.* 1997, Ravindranath and Ostwald (2008), Ajani and Shams 2016). By multiplying above-ground biomass with 0.26 (default value), which was taken as the root to shoot ratio, the Below Ground Biomass (roots) was calculated (Chavan and Rasal2011, Ajani and Shams 2016).BGB (ton/tree) =AGB (ton/tree) x 0.26 while Biomass = BGB + AGB.

C) Calculating carbon sequestration

In order to obtain the sequestered carbon, the biomass (Biomass = BGB +AGB) of the trees is calculated dividing by (2) two. This is done on the basis of the fact that the trees contain on an average 50% carbon in different parts of their biomass (Ajani and Shams, 2016). Carbon Sequestered = Biomass /2

3. RESULT AND DISCUSSION

The non-destructive method was carried out for carbon sequestration and biomass calculation of two selected species of Conocarpus erectus and Azadirachta indica. Plant height, DBH, AGB, BGB, Biomass and carbon sequestration of both tree plants were calculated as presented in Table 1 - 2. The mean plant height of both tree plants Azadirachta indica and Conocarpus erectuswas observed 890cm ±52.92 and 796.5cm ±93.7 respectively. Thetree bole mean diameter was observed 26.43cm±3.76 and 12.10cm ±3.20 ofAzadirachta indica and Conocarpus erectus respectively as presented in table 1 &2. The mean above ground biomass (AGB) of Azadirachta indica and Conocarpus erectus was 298.35kg ±51.26 and 279.15 kg ±32.87respectively. The mean, below ground biomass (BGB) of Azadirachta indica and Conocarpus erectus was 77.57kg ±13.32 and 72.57kg ±8.54 respectively. The mean total biomass (AGB+BGB) of Azadirachta indica and Conocarpus erectuswas 375.93 kg±64.59 and 351.73kg ±41.41 respectively. Carbon Sequestration mean of both species Azadirachtaindica and Conocarpus erectus was 187.96± 20.70 and 175.86± 20.70 respectively as presented in **(Table 1-2).**

Table 1, Showing Height, DBH, AGB, BGB, Biomass and carbon sequestration of plant Azardirachta indica.

		Plant height (cm)	Tree bole diameter at breast height (DBH)(cm)	Above ground biomas (AGB) in Kg	Below ground biomass (BGB) in Kg	Biomass (AGB +BGB) in Kg	Carbon Sequestered in kg
1	Azadirachta indica	787.5	25.47	263.99	68.63	332.63	166.31
2	Azadirachta indica	800	30.25	268.18	69.72	337.91	168.95
3	Azadirachta indica	630	17.51	211.19	54.91	266.10	133.05
4	Azadirachta indica	922.5	27.07	309.25	80.40	389.65	194.82
5	Azadirachta indica	1125	27.07	377.13	98.05	475.19	237.59
6	Azadirachta indica	1102.5	30.25	369.59	96.09	465.69	232.84
7	Azadirachta indica	967.5	28.66	324.33	84.32	408.66	204.33
8	Azadirachta indica	765	23.88	256.45	66.67	323.13	161.56
9	Azadirachta indica	877.5	25.47	294.16	76.48	370.65	185.32
10	Azadirachta indica	922.5	28.66	309.25	80.40	389.65	194.82
Mean		890	26.43	298.35	77.57	375.93	187.96
St. Dev.		±52.92	± 3.76	±51.26	±13.32	±64.59	±32.29
Maximum		1125	30.25	377.13	98.05	475.19	237.59
Minimum		630	17.51	211.19	54.91	266.10	133.05

Table 2, Showing Height, DBH, AGB, BGB, Biomass and carbon sequestration of plant Conocarpus erectus.

		Plant height (cm)	Tree bole diameter at breast height (DBH)(cm)	Above ground biomas (AGB) in Kg	Below ground biomass (BGB) in Kg	Biomass (AGB +BGB) in Kg	Carbon Sequestered in kg
1	Conocarpus erectus	945	17.51	331.19	86.11	417.30	208.65
2	Conocarpus erectus	855	14.33	299.65	77.91	377.56	188.7819822
3	Conocarpus erectus	810	12.73	283.88	73.80	357.69	178.84
4	Conocarpus erectus	922.5	15.92	323.31	84.06	407.37	203.68
5	Conocarpus erectus	697.5	11.14	244.45	63.55	308.01	154.00
6	Conocarpus erectus	810	12.73	283.88	73.80	357.69	178.84
7	Conocarpus erectus	787.5	11.14	275.99	71.75	347.75	173.87
8	Conocarpus erectus	652.5	7.96	228.68	59.45	288.14	144.07
9	Conocarpus erectus	765	9.55	268.11	69.70	337.82	168.91
10	Conocarpus erectus	720	7.96	252.34	65.60	317.94	158.97
Mean		796.5	12.10	279.15	72.57	351.73	175.86
St. Dev.		±93.7	±3.20	±32.87	± 8.54	±41.41	± 20.70
Maximum		945	17.51	331.19	86.11	417.30	208.65
Minimum		652.5	7.96	228.68	59.45	288.14	144.07

4. CONCLUSION

The two plant species Azadirachta indica and Conocarpus erectus at Sindh Madressatul Islam University campus were brought under study through nondestructive method, for understanding the potential of carbon sequestration.Comparative study reveals that Azadirachtaindica sequestrates more carbon as compared to Conocarpus erectus within same environmental conditions.All parameters as plant height, DBH, AGB, BGB, Biomass and carbon sequestration of plant Azardirachta indica were found higher as compared to Conocarpus erectus.The mean plant height of Azadirachta indica was higher (890cm) as compared Conocarpus erectus (796.5cm).The tree bole mean diameter was higher (26.43cm) of Azadirachtaindica as compared Conocarpus erectus (12.10cm). The mean above ground biomass (AGB) of Azadirachta indica was found higher (298.35kg) as compared Conocarpus erectus (279.15kg). The mean, below ground biomass (BGB) of Azadirachta indica was higher (77.57kg)as compared Conocarpus. Erectus (72.57kg). The mean total biomass (AGB +BGB) of Azadirachtaindica was higher (375.93kg) as compared to Conocarpus erectus (351.73kg).The meanCarbon Sequestration Azadirachtaindica was found higher (187.96kg) as compared Conocarpuserectus (175.86kg). Carbon sequestration of Azadirachta indica was 51.6% as compared to Conocarpus erectus 48.33 %.

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