__Original Research Article__

OXYGEN PRODUCTION AND CARBON CAPTURING CAPACITY OF VARIOUS TREE SPECIES IN COIMBATORE CITY

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ABSTRACT

Climate change, environment pollution, rapid urbanization and industrialization have been recognized as major environmental threats of the present-day scenario. These environmental issues cause severe socio-economic implications across the globe. The living space and human settlements are increasing rapidly in urban areas of India. Simultaneously the existing green cover and tree population are declining in the name of developments. Trees are considered to be one of the important assets in cities, they provide myriad benefits. Considering the important of the trees in the cities and their role in reducing the pollution besides adding fresh oxygen to the atmosphere. The present investigation focused with the aim of documenting various tree species in Coimbatore city and to assess their carbon capturing and oxygen release potential. There are about 58 tree species comprising of 27 families, that have been documented and classified into four age classes. Further these tree species were subjected to total biomass, carbon stock, CO_2 (eq.), net carbon sequestration and net oxygen release assessment using standard non-destructive method. Among the 58 tree species studied, *Albizialebbeck*(2.745 ton tree^{-1}year^{-1}), *Tamarindusindica*(2.156 ton tree^{-1}year^{-1}), *Parkiabiglandulosa*(1.921 ton tree^{-1}year^{-1}), *Delonixregia*(1.027 ton tree^{-1}year^{-1}), *Kigelia Africana* (1.009 ton tree^{-1}year^{-1}), *Peltophorumpterocarpum*(1.006 ton tree^{-1}year^{-1}), *Ficusreligiosa*(0.906 ton tree^{-1}year^{-1}), *Leucaenaleucocephala*(0.836 ton tree^{-1}year^{-1}), *Pterospermumacerifolium*(0.827 ton tree^{-1}year^{-1}) and *Azadirachtaindica*(0.804 ton tree^{-1}year^{-1}) were found to release high oxygen with more carbon capturing capacity.

Keywords:Urban trees, air pollution, carbon stock, net carbon sequestration and net oxygen release

1. INTRODUCTION

Good air quality is an essential to welfare of human beings and other living things. The quality of air is deteriorating at faster rate through transportation, urbanisation, industrial and natural activities. Air pollution has adverse consequences on living things, human health, and environmental resources, either directly or indirectly [1]. Major air pollutants in the urban area are carbon dioxide (CO_2), carbon monoxide (CO), particulate matter ($PM_{2.5}$ and PM_{10}), hydrocarbons (HC), oxides of nitrogen (NO_x) and other fuel exhaust [2]. Carbon dioxide, the most significant of all greenhouse gases (GHGs) has gradually increased since the commencement of the industrialization, from 280 ppm to 415 ppm [3] and it is expected to rise above the level of 480 ppm by 2050 [4]. World Bank estimates, China and India have CO_2 emissions of 7.5 Mg and 1.6 Mg per person in a year respectively, whereas the United States has 17.5 Mg [5]. Trees are known to be more effective to combat air pollution, capture carbon and reduce ultraviolet radiation in addition to release of oxygen. [6] reported that trees control micro-climate by regulating carbon dioxide (CO_2), oxygen (O_2) sulphur dioxide (SO_2), particulate matter ($PM_{2.5}$ and PM_{10}), and ozone (O_3) [7, 8]. According to [9] a hectare *Eucalyptus tereticornis*plantation release 431 ton of oxygen per year and sequestrated 161.8 ton of carbon in Dharwad, which plays a major role in improving air quality.

Coimbatore covers 4,732 km^2, of which 34.4% is under rapid urbanisation with more than 25,000 industries comprising textile mills, electroplating and manufacturing of industrial equipment, spares, motor pump sets [10]. Owing to the rapid urbanisation, the vegetation cover declined about 25.28% (9.60 km^2) which was 65.22 km^2 in 2003 and urban area coverage changed from 18.07% in 2003 to 54.32 % [11]. In this regard, the government has initiated Smart City project emphasizing the increase of green cover. To successfully implement this project, an action plan with list of trees which has high carbon sequestrating, large canopy and high oxygen releasing capacity is vital. Hence, this study aims to screen the trees in a local region based on their carbon capture and oxygen release potential, and help the policy makers along with urban planners to understand the role of trees in global carbon cycle and climate change mitigation and for healthy living of people.

2. MATERIAL AND METHODS

2.1 Study area

The study area, Coimbatore city (11° 01' 2'' N, 76° 57' 31'' E), is the second-largest city located in Tamil Nadu. It is an upcoming smart city with a projected 2 million residents and is also known as the textile capital and the Manchester of South India, one of the most industrialized cities in Tamil Nadu. The annual rainfall is about 618 mm, and the average monthly temperature varies between 20.6 and 38.4 °C. The carbon sequestration and oxygen production of the selected 58 tree species were carried out from three strategic locations Bharathi park (11°01'12'' N, 76°56'50'' E), Gandhi Park (11°00'03'' N, 76°57'03'' E) and VOC park (11°00'24'' N, 76°58'12'' E) (Figure 1.) of Coimbatore city.

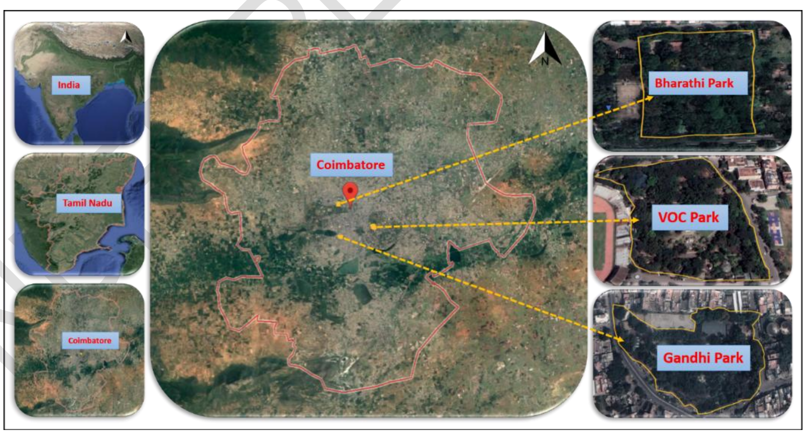

Fig. 1. Satellite view of the site of investigation

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2.2 Site survey

The primary biophysical measurements (Height and DBH) of identified 58 species were done by using laser rangefinder (Bosch Glm 500 Laser Distance Measurement Device) and measuring tape (Figure 2a). The location of the study area was recorded by Geographical Positioning System (GPS) Model (Garmin- eTrex Legend HCx) (Figure 2b).

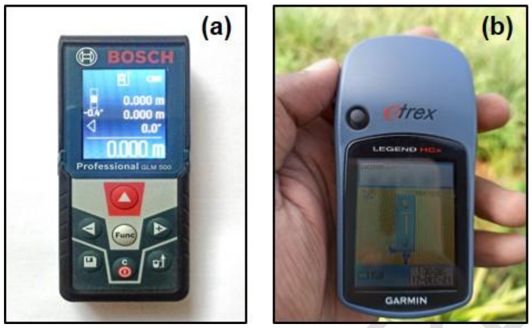

Fig.2. (a) Laser rangefinder (Bosch Glm 500 Laser Distance Measurement Device), (b) Geographical Positioning System (GPS)

2.3 Tree DBH and its measurements

Tree DBH is a standard and the most common method of measuring the diameter of a tree trunk measured at breast level as a convenient way of measurement during which one does not need to bend the waist or climb up a ladder to take the measurement. DBH or circumference of the tree was measured by tightly wrapping tape around the tree's main trunk at a height of 1.37 m from the ground [12]. During measurement, the tape was loosened and re-tighten a couple of times or slide around the trunk to ensure the tape lies flat and was not obstructed by any swollen parts of the trunk**.**

2.4 Tree height and its measurements

Tree height is a fundamental geometrical variable for trees as it has some vertical distance between the base of the tree and the highest point on the tree [13]. The tree height was measured by using a laser rangefinder (Bosch Glm 500 Laser Distance Measurement Device) (Figure 2a.). Laser rangefinder device works on the mechanism of using a laser beam, to determine the distance to an object (tree) and is kept on a tripod stand for more accuracy. The device transmits a narrow laser pulse beam towards the target and measures the time it takes for the pulse to be reflected off the target (tree) and returned to the sender. In order to make correct calculations of the vertical distance between any two points automatically as it works with one point at the top of the tree and another point at the base of the tree and thereby generates the tree height. After arriving tree DBH and height, net O_2 release and net C sequestration were calculated by the following procedure.

The basic parameters required for estimating net O_2 release (kg yr^{-1}) and net C sequestration (kg yr^{-1}), includes tree DBH, tree height, Total biomass, Carbon stock and CO_2 (eq.).

2.5.1 Measuring the tree volume

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By using tree DBH and height, the volume of the tree was estimated [14].:

$V = \pi r^2 h$

Where,

V = Volume of the tree in m^3

r = Radius of the trunk in m

h = Height of the tree in m

2.5.2 Above Ground Biomass and Below Ground Biomass

The Above Ground Biomass (AGB) was calculated by multiplying the volume of biomass and wood density, [15].

AGB = V x D

Where,

AGB = Above Ground Biomass

V = Volume of tree in m^3

D = Wood density of the tree species*

*Wood density was obtained from the global wood density database [16]. The standard average density of 0.6 g/cm^3 is applied wherever the density value is not available for tree species.The Below Ground Biomass (BGB) was calculated by multiplying above-ground biomass with 0.26 as the root shoot ratio [14].

BGB = AGB x 0.26

Total Biomass (TB) was calculated by summing the ABG and BGB [17].

Total Biomass (TB) = AGB + BGB

Where,

AGB = Above Ground Biomass.

BGB = Below Ground Biomass

2.5.3 Carbon sequestration potential of selected tree species

According to various scientific research reports, For any tree species, 50% of its biomass is considered as its carbon stock[18]. By using the following formula, the carbon stock of the tree species was calculated:

Carbon stock = Total Biomass x 0.5

After arriving the Carbon stock of each tree, the carbon sequestrated potential in terms of CO_2 (eq.) was calculated by using the following formula:

CO_2 (eq.) = (Carbon stock x 44) / 12

CO_2 is composed of 2 molecules of Oxygen(O_2) and 1 molecule of Carbon(C). The atomic weight of carbon is 12. The atomic weight of Oxygen is 16. Therefore, the weight of CO_2 is Carbon + (2 x Oxygen) = 44. The ratio of CO_2 to C is 44/12 = 3.666. So, to evaluate the carbon dioxide equivalent in the tree, multiply the carbon stock in the tree by 3.666.

The quantity of total CO_2 sequestered in in terms of CO_2 (eq.) of the tree during its entire lifespan is represented by the above equation. To obtain a yearly C sequestration rate, the overall CO_2equivalent by the tree was divided by its age[19].

Net C sequestration = CO_2 (eq.) / age of the tree

2.5.4 Oxygen release by trees

The amount of oxygen produced during photosynthesis is subtracted from the amount of oxygen absorbed during plant respiration to calculate net oxygen production by trees [20].

Photosynthesis : $n(CO_2) + n(H_2O) + \text{light} \rightarrow (CH_2O)n + nO_2$
Respiration : $(CH_2O)n + nO_2 \rightarrow n(CO_2) + n(H_2O) + \text{energy}$

The tree will acquire carbon if carbon dioxide intake during photosynthesis exceeds carbon dioxide released during respiration over the course of the year (carbon sequestration). As a result, a tree that accumulates a net amount of carbon over the course of a year (tree growth) also produces a net amount of oxygen. Carbon sequestration produces an estimated quantity of oxygen based on atomic weights.
Net oxygen production by trees is estimated by the following formula [21]:

Net O_2 release (kg yr^{-1}) = Net C sequestration (kg yr^{-1}) x 32 / 12

3. RESULTS AND DISCUSSION

The National Forest Policy (1988) stipulates that in order to maintain and increase the amount of forest cover, trees should cover one-third of each state's land area [22]. The government of Coimbatore has made huge initiatives to raise the number of trees in both forested and non-forested (urban) regions. The current study estimates carbon sequestration and oxygen production potential in Coimbatore city. To determine the ability of selected tree specie's carbon sequestration and oxygen production potential, a study involving field surveys, and allometric equations were employed.

About 58 tree species namely *Spathodeacampanulata*(African tulip), *Terminaliaarjuna*(Arjuna tree), *Clusiarosea*(Balsom apple), *Parkiabiglandulosa*(Ball badminton), *Terminaliabellirica*(Bedda nut tree), *Paubrasiliaechinata* (Brazilwood), *Madhucalongifolia* (Butter tree), *Couroupitaguianensis* (Cannon ball), *Casuarinaequisetifolia*(Casuarina), *Phoenix pusilla*(Ceylon Date Palm), *Ficusracemosa*(Cluster fig), *Cocosnucifera*(Coconut), *Lagunariapatersonia*(Cow itch), *Tabebuiaheterophylla*(Cuban pink), *Bergerakoenigii*(Curry leaf), *Acacia auriculiformis*(Earleaf acacia), *Polyalthialongifolia*(False Ashoka), *Caryotamitis*(Fishtail palm), *Cordiasebestena*(Geranium), *Cassia fistula* (Golden shower), *Phyllanthusemblica*(Gooseberry), *Psidiumguajava*(Guava), *Terminaliacatappa*(Indian almond), *Malpighiaemarginata*(Indian cherry), *Millingtoniahortensis*(Indian cork), *Albizialebbeck*(Indian siris), *Thespesiapopulnea*(Indian tulip), *Syzygiumcumini*(Jamun), *Pterospermumacerifolium*(KanakChampa), *Mangiferaindica*(Mango), *Delonixregia*(May flower), *Hippocrateavolubilis*(Medicine vine), *Morindatinctorial*(Indian mulberry), *Morus spp.* (Mulberry), *Azadirachtaindica*(Neem), *Araucaria heterophylla*(Norfolk Island pine), *Simaroubaglauca*(Paradise), *Nyctanthesarbor-tristis*(Parijat), *Paulownia tomentosa*(Princess), *Millettiapinnata*(Pungam), *Bauhinia purpurea*(Purple bauhinia), *Gliricidiasepium*(Quick stick), *Leucaenaleucocephala*(River tamarind), *Roystonearegia*(Royal palm), *Ficusreligiosa*(Sacred fig), *Santalum album* (Sandal), *Manilkarazapota*(Sapota), *Kigelia Africana* (Sausage), *Mimusopselengi*(Spanish Cherry), *Tamarindusindica*(Tamarind), *Tectonagrandis*(Teak), *Tipuanatipu*(Tipu), *Ficusbenjamina*(Weeping fig), *Sterculiafoetida*(Wild almond), *Limoniaacidissima*(Wood apple), *Tecomastans*(Yellow bells), *Peltophorumpterocarpum*(Yellow flame) and *Bambusa vulgaris* (Bamboo) where documented and categorized into four age classes. As these tree species were abundant in wasteland, sides of roads and canals, lake areas and next to railroad tracks, Further investigation were carried out to assess their Carbon sequestration and O_2 release potential. Previous studies show long-term air purification and soot filtration are accomplished by these trees, which also serve as "green highways" for the migration of birds, insects, and other natural animals [23].

These fifty-eight-tree species of different age classes were classified into four categories based on their age class (A = 5 to 10 years, B = 11 to 20 years, C = 21 to 30 years, D = >30 years) (Table 1.). In order to avoid error while estimating the total biomass, carbon sequestration and oxygen release potential, the age of the trees was ascertained from the information available in the tree register of the different parks (Bharathi park, Gandhi park, VOC park) of Coimbatore city taken for the study.

The trees were listed in an alphabetic order with respect to their common name. The scientific name and family name were confirmed in consultation with scientists from Forest College and Research Institute (FC&RI) – Mettupalayam, Institute of Forest Genetics and Tree Breeding (IFGTB) – Coimbatore and Botanical Survey of India – Coimbatore. Then the tree species were listed and separated according to their age class – A, B, C, and D for easy comparison and interpretation of data.

3.1 Volume and total biomass of selected tree species

In this study, Among these 58 species *Albizialebbeck*(32296.70kg $tree^{-1}$), *Tamarindusindica*(24268.03 kg $tree^{-1}$), *Parkiabiglandulosa*(14154.94 kg $tree^{-1}$), *Delonixregia*(11559.99 kg $tree^{-1}$), *Peltophorumpterocarpum*(11316.93 kg $tree^{-1}$), *Kigelia Africana* (8774.07 kg $tree^{-1}$), *Azadirachtaindica*(7405.90 kg $tree^{-1}$), *Ficusreligiosa*(6488.67 kg $tree^{-1}$), *Couroupitaguianensis*(5231.09 kg $tree^{-1}$)and *Acacia auriculiformis*(4795.94 kg $tree^{-1}$)were the top ten s tree species in terms of highest total biomass (Table 2). [24, 25] stated that the biomass of tree species varied with their tree volume. *Albizialebbeck* (32296.70kg $tree^{-1}$) recorded the highest total biomass in the study area followed by, *Tamarindusindica*(24268.03 kg $tree^{-1}$), *Parkiabiglandulosa*(14154.94 kg $tree^{-1}$)and *Delonixregia*(11559.99 kg $tree^{-1}$) (Figure 3). *Malpighiaemarginata*(19.57 kg $tree^{-1}$)had the lowest biomass in the study area followed by *Nyctanthes arbour tristis*(20.75 kg $tree^{-1}$), *Manilkarazapota*(21.02 kg $tree^{-1}$), *Caryotamitis*(24.62 kg $tree^{-1}$) and *Clusiarosea*(25.32 kg $tree^{-1}$)(Table 2). [26] stated that individual trees of the same species may develop differently and produce different amounts of biomass at various locations. Trees with huge canopies, enhance photosynthesis rates and its biomass [27].

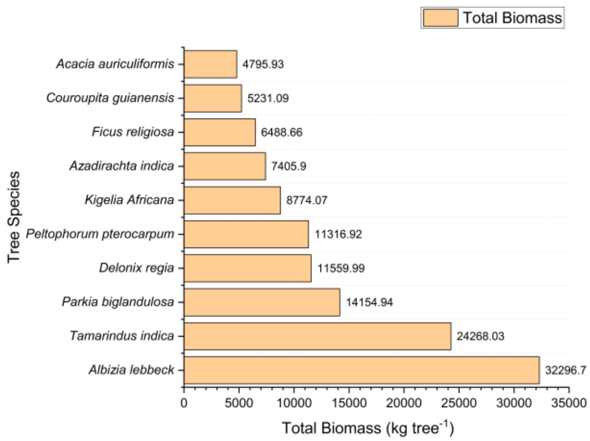

Fig. 3. Top ten tree species of Coimbatore city with the highest biomass.

3.2 Carbon stock and CO_2 (eq.) of selected tree species

The carbon stock of selected 58 tree species were ranges from 16148.35 kg tree^{-1} to 9.78 kg tree^{-1} (Table 3). Among these selected 58 tree species, the highest Carbon stock was recorded in *Albizialebbeck* (16148.35 kg tree^{-1}), *Tamarindusindica*(12134.02 kg tree^{-1}), *Parkiabiglandulosa*(7077.47 kg tree^{-1}), *Delonixregia*(5780.00 kg tree^{-1}), *Peltophorumpterocarpum*(5658.46 kg tree^{-1}), *Kigelia Africana* (4387.04 kg tree^{-1}), *Azadirachtaindica*(3702.95 kg tree^{-1}), *Ficusreligiosa*(3244.33 kg tree^{-1}), *Couroupitaguianensis*(2615.55 kg tree^{-1}), *Acacia auriculiformis*(2397.97 kg tree^{-1}) (Table 3). *Malpighiaemarginata*(9.78 kg tree^{-1}), *Nyctanthesarbortristis*(10.37kg tree^{-1}), *Manilkarazapota*(10.512 kg tree^{-1}), *Caryotamitis*(12.30 kg tree^{-1}) and *Clusiarosea*(12.662 kg tree^{-1}) were among the species with lowest carbon stock (Table 3). The total CO_2 (eq.) of these 58 tree species were ranged from 59199.85 kg tree^{-1} to 35.87 kg tree^{-1}. *Albizialebbeck*(59199.85 kg tree^{-1}) sequestered the highest CO_2 (eq.), followed by *Tamarindusindica*(44483.30 kg tree^{-1}), *Parkiabiglandulosa*(25946.01 kg tree^{-1}), *Delonixregia*(21189.46 kg tree^{-1}), *Peltophorumpterocarpum*(20743.92 kg tree^{-1}), *Kigelia Africana* (16082.87 kg tree^{-1}), *Azadirachtaindica*(13575.02 kg tree^{-1}), *Ficusreligiosa*(11893.73 kg tree^{-1}), *Couroupitaguianensis*(9588.60 kg tree^{-1}) and *Acacia auriculiformis*(8790.96 kg tree^{-1}) (Table 3).*Malpighiaemarginata*(35.87 kg tree^{-1}), *Nyctanthesarbortristis*(38.03 kg tree^{-1}), *Manilkarazapota*(38.54 kg tree^{-1}), *Caryotamitis*(45.12 kg tree^{-1}) and *Clusiarosea*(46.42 kg tree^{-1}) were the species with lowest CO_2 (eq.) (Table 3). The carbon stock is influenced by the tree species volume growth [12, 28, 29].

3.3 Net carbon sequestration and net oxygen release

Net carbon sequestration of selected tree species ranged from 1.03 ton tree^{-1}year^{-1} to 0.004 ton tree^{-1}year^{-1} (Table 3). The tree species with the highest potential for net carbon sequestration were *Albizialebbeck*(1.03 ton tree^{-1}year^{-1}) followed by *Tamarindusindica*(0.809 ton tree^{-1}year^{-1}), *Parkiabiglandulosa*(0.721 ton tree^{-1}year^{-1}), *Delonixregia*(0.385 ton tree^{-1}year^{-1}), *Kigelia Africana* (0.378 ton tree^{-1}year^{-1}), *Peltophorumpterocarpum*(0.377 ton tree^{-1}year^{-1}), *Ficusreligiosa*(0.340 ton tree^{-1}year^{-1}), *Leucaenaleucocephala*(0.314 ton tree^{-1}year^{-1}), *Pterospermumacerifolium*(0.310 ton tree^{-1}year^{-1}) and *Azadirachtaindica*(0.302 ton tree^{-1}year^{-1}) . *Caryotamitis*(0.004 ton tree^{-1}year^{-1}) and *Malpighiaemarginata*(0.006 ton tree^{-1}year^{-1}) were the species with the lowest net carbon sequestration (Figure 4). The net oxygen release, of selected tree species were ranged from 2.745 ton tree^{-1}year^{-1} to 0.011 ton tree^{-1}year^{-1} (Table 3). The tree species with the highest potential for net oxygen release were*Albizialebbeck*(2.745 ton tree^{-1}year^{-1}), *Tamarindusindica*(2.156 ton tree^{-1}year^{-1}), *Parkiabiglandulosa*(1.921 ton tree^{-1}year^{-1}), *Delonixregia*(1.027 ton tree^{-1}year^{-1}), *Kigelia Africana* (1.009 ton tree^{-1}year^{-1}), *Peltophorumpterocarpum*(1.006 ton tree^{-1}year^{-1}), *Ficusreligiosa*(0.906 ton tree^{-1}year^{-1}), *Leucaenaleucocephala*(0.836 ton tree^{-1}year^{-1}), *Pterospermumacerifolium*(0.827 ton tree^{-1}year^{-1}) and *Azadirachtaindica*(0.804 ton tree^{-1}year^{-1}). *Caryotamitis*(0.011 ton tree^{-1}year^{-1}) and *Malpighiaemarginata*(0.015 ton tree^{-1}year^{-1}) were the species with the lowest net oxygen release (Table 3; Figure 4). Oxygen production varies by tree size, age and type of species. Oxygen production regulates the metabolic process of living things, it is clear that the production of oxygen by trees is a crucial ecological service [30]. Similar results were reported by [9].

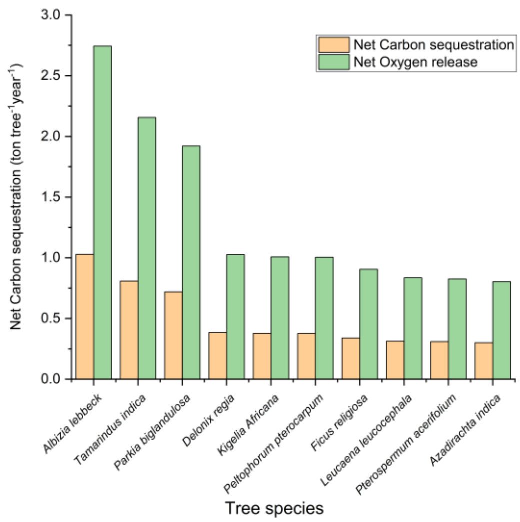

Fig. 4. Top ten tree species of Coimbatore city with the highest Net carbon sequestration and Net oxygen release.

Table 1. List of tree species selected for the study

Common Name	Scientific Name	Family	App. age (In years)	Avg. age (In years)	Age class. (In years)
African tulip	*Spathodeacampanulata*	Bignoniaceae	8-10	9	A
Arjuna tree	*Terminalia arjuna*	Combretaceae	5-10	8	A
Balsom apple	*Clusiarosea*	Clusiaceae	5-8	7	A
Ball badminton	*Parkiabiglandulosa*	Mimosoideae	35-37	36	D
Bibhitaki	*Terminaliabellirica*	Combretaceae	10-12	11	B
Brazilwood	*Paubrasiliaechinata*	Fabaceae	10-15	13	B
Butter tree	*Madhucalongifolia*	Sapotaceae	8-12	10	A
Cannon ball tree	*Couroupitaguianensis*	Lecythidaceae	40-50	45	D
Casuarina	*Casuarinaequisetifolia*	Casuarinaceae	8-12	10	A
Ceylon Date Palm	*Phoenix pusilla*	Arecaceae	8-12	10	A
Cluster fig	*Ficusracemosa*	Moraceae	10-15	13	B
Coconut	*Cocos nucifera*	Arecaceae	18-20	19	B
Cow itch	*Lagunariapatersonia*	Malvaceae	10-15	13	B
Cuban pink	*Tabebuiaheterophylla*	Bignoniaceae	15-20	18	B
Curry leaf	*Bergerakoenigii*	Rutaceae	8-12	10	A
Earleaf acacia	*Acacia auriculiformis*	Fabaceae	40-45	43	D
False Ashoka	*Polyalthialongifolia*	Annonaceae	50-55	53	D
Fishtail palm	*Caryotamitis*	Arecaceae	10-12	11	B
Geranium	*Cordiasebestena*	Boraginaceae	5-8	7	A
Golden shower	*Cassia fistula*	Fabaceae	6-8	7	A
Gooseberry	*Phyllanthusemblica*	Euphorbiaceae	10-12	11	B
Guava	*Psidiumguajava*	Myrtaceae	5-8	7	A
Indian almond	*Terminaliacatappa*	Combretaceae	8-10	9	A
Indian cherry	*Malpighiaemarginata*	Malpighiaceae	5-8	7	A
Indian cork	*Millingtoniahortensis*	Bignoniaceae	10-15	13	B
Indian siris	*Albizialebbeck*	Fabaceae	55-60	58	D

Common Name	Scientific Name	Family	App. age (In years)	Avg. age (In years)	Age class. (In years)
Indian tulip	*Thespesiapopulnea*	Malvaceae	5-8	7	A
Jamun	*Syzygiumcumini*	Myrtaceae	20-25	23	C
KanakChampa	*Pterospermumacerifolium*	Sterculiaceae	25-30	28	C
Mango	*Mangiferaindica*	Anacardiaceae	15-20	18	B
May flower	*Delonixregia*	Fabaceae	50-60	55	D
Medicine vine	*Hippocrateavolubilis*	Celastraceae	12-15	14	B
Indian mulberry	*Morindatinctoria*	Rubiaceae	8-10	9	A
Mulberry	*Morus spp.*	Moraceae	10-12	11	B
Neem	*Azadirachtaindica*	Meliaceae	40-50	45	D
Norfolk Island pine	*Araucaria heterophylla*	Araucariaceae	8-10	9	A
Paradise	*Simaroubaglauca*	Simaroubacea	10-12	11	B
Parijat	*Nyctanthes arbor-tristis*	Oleaceae	5-8	7	A
Princess trees	*Paulownia tomentosa*	Paulowniaceae	5-8	7	A
Pungam	*Millettiapinnata*	Fabaceae	20-25	23	C
Purple bauhinia	*Bauhinia purpurea*	Fabaceae	10-15	13	B
Quick stick	*Gliricidiasepium*	Fabaceae	30-35	33	D
River tamarind	*Leucaenaleucocephala*	Fabaceae	10-18	14	B
Royal palm	*Roystonearegia*	Arecaceae	20-25	23	C
Sacred fig	*Ficusreligiosa*	Moraceae	30-40	35	D
Sandal	*Santalum album*	Santalaceae	15-20	18	B
Sapota	*Manilkarazapota*	Sapotaceae	5-8	7	A
Sausage	*Kigelia Africana*	Bignoniaceae	40-45	43	D
Spanish Cherry	*Mimusopselengi*	Sapotaceae	25-30	28	C
Tamarind	*Tamarindusindica*	Fabaceae	50-60	55	D
Teak	*Tectonagrandis*	Lamiaceae	20-25	23	C
Tipu	*Tipuanatipu*	Fabaceae	12-15	14	B
Weeping fig	*Ficusbenjamina*	Moraceae	15-18	17	B

Common Name	Scientific Name	Family	App. age (In years)	Avg. age (In years)	Age class. (In years)
Wild almond	*Sterculiafoetida*	Malvaceae	15-18	17	B
Wood apple	*Limoniaacidissima*	Rutaceae	35-40	38	D
Yellow bells	*Tecomastans*	Bignoniaceae	5-8	7	A
Yellow flame	*Peltophorumpterocarpum*	Fabaceae	50-60	55	D
Bamboo	*Bambusa vulgaris*	Poaceae	5-15	10	A

* A = 5 to 10 years, B = 11 to 20 years, C = 21 to 30 years, D = > 30 years.

Table 2. Volume and total biomass of the selected tree species in Coimbatore city

Scientific Name	Height (m)	DBH (m)	Volume (kg m^{-3})	Wood density (kg m^{-3})	Above Ground Biomass (kg $tree^{-1}$)	Below Ground Biomass (kg $tree^{-1}$)	Total biomass (kg $tree^{-1}$)
Spathodeacampanulata	8.16	0.93	0.56	330	185.43	48.21	233.64
Terminalia arjuna	5.66	0.35	0.06	800	44.16	11.48	55.64
Clusiarosea	5.10	0.27	0.03	679	20.10	5.23	25.32
Parkiabiglandulosa	18.31	3.47	17.55	640	11234.08	2920.86	14154.94
Terminaliabellirica	10.02	0.81	0.52	697	364.82	94.85	459.68
Paubrasiliaechinate	12.23	1.13	1.24	600	746.01	193.96	939.97
Madhucalongifolia	9.22	0.72	0.38	790	300.63	78.16	378.79
Couroupitaguianensis	16.36	2.71	9.57	434	4151.66	1079.43	5231.09
Casuarinaequisetifolia	12.02	0.63	0.38	918	348.69	90.66	439.35
Phoenix pusilla	9.83	0.94	0.69	600	414.93	107.88	522.81
Ficusracemosa	23.40	1.23	2.82	375	1056.98	274.82	1331.80
Cocos nucifera	17.28	0.88	1.07	616	656.30	170.64	826.93
Lagunariapatersonia	5.23	1.29	0.69	600	415.76	108.10	523.86
Tabebuiaheterophylla	12.71	1.920	3.73	589	2197.22	571.28	2768.50
Bergerakoenigii	7.45	0.57	0.19	600	115.63	30.06	145.69

Scientific Name	Height (m)	DBH (m)	Volume (kg m^{-3})	Wood density (kg m^{-3})	Above Ground Biomass (kg $tree^{-1}$)	Below Ground Biomass (kg $tree^{-1}$)	Total biomass (kg $tree^{-1}$)
Acacia auriculiformis	15.60	2.26	6.34	600	3806.30	989.64	4795.94
Polyalthialongifolia	17.01	0.93	1.17	563	659.46	171.46	830.92
Caryotamitis	8.45	0.220	0.03	600	19.54	5.08	24.62
Cordiasebestena	7.32	0.63	0.23	700	161.92	42.10	204.02
Cassia fistula	9.20	0.97	0.69	829	571.34	148.55	719.89
Phyllanthusemblica	10.50	1.270	1.35	728	981.61	255.22	1236.83
Psidiumguajava	5.94	0.87	0.36	671	240.19	62.45	302.64
Terminaliacatappa	11.08	0.56	0.28	540	149.39	38.84	188.23
Malpighiaemarginata	3.70	0.294	0.03	610	15.53	4.04	19.57
Millingtoniahortensis	11.23	1.460	1.91	600	1143.53	297.32	1440.85
Albizialebbeck	19.23	5.30	43.01	596	25632.30	6664.40	32296.70
Thespesiapopulnea	7.20	1.31	0.98	639	628.62	163.44	792.06
Syzygiumcumini	10.50	1.78	2.65	701	1856.77	482.76	2339.53
Pterospermumacerifolium	13.50	2.35	5.94	622	3692.07	959.94	4652.01
Mangiferaindica	12.45	0.77	0.59	597	350.86	91.22	442.09
Delonixregia	16.42	3.42	15.29	600	9174.60	2385.40	11559.99
Hippocrateavolubilis	9.23	0.67	0.33	875	288.65	75.05	363.70
Morindatinctorial	12.03	0.72	0.50	540	268.12	69.71	337.84
Morus spp.	16.10	0.77	0.76	590	448.40	116.59	564.99
Azadirachtaindica	19.03	2.310	8.08	727	5877.70	1528.20	7405.90
Araucaria heterophylla	3.30	0.520	0.07	548	38.93	10.12	49.05
Simaroubaglauca	10.63	1.335	1.51	378	570.16	148.24	718.40
Nyctanthes arbor-tristis	3.76	0.250	0.02	880	16.46	4.28	20.75
Paulownia tomentosa	7.20	1.45	1.21	330	397.73	103.41	501.14
Millettiapinnata	16.70	1.29	2.21	619	1369.61	356.10	1725.71

Scientific Name	Height (m)	DBH (m)	Volume (kg m^{-3})	Wood density (kg m^{-3})	Above Ground Biomass (kg $tree^{-1}$)	Below Ground Biomass (kg $tree^{-1}$)	Total biomass (kg $tree^{-1}$)
Bauhinia purpurea	7.99	0.910	0.53	720	379.29	98.62	477.91
Gliricidiasepium	7.23	0.87	0.44	684	298.02	77.48	375.50
Leucaenaleucocephala	14.20	1.62	2.97	641	1901.90	494.49	2396.39
Roystonearegia	15.69	1.34	2.24	600	1345.84	349.92	1695.76
Ficusreligiosa	18.36	2.82	11.62	443	5149.74	1338.93	6488.67
Santalum album	9.97	0.38	0.11	936	107.29	27.89	135.18
Manilkarazapota	4.10	0.237	0.02	910	16.69	4.34	21.02
Kigelia Africana	14.90	2.98	10.53	661	6963.55	1810.52	8774.07
Mimusopselengi	10.40	1.43	1.69	882	1493.43	388.29	1881.72
Tamarindusindica	16.40	3.86	19.45	990	19260.34	5007.69	24268.03
Tectonagrandis	19.12	1.250	2.38	612	1455.69	378.48	1834.17
Tipuanatipu	11.30	1.23	1.36	587	798.98	207.74	1006.72
Ficusbenjamina	12.20	1.620	2.55	499	1272.04	330.73	1602.77
Sterculiafoetida	12.35	1.240	1.51	552	834.56	216.99	1051.55
Limoniaacidissima	15.26	1.36	2.25	771	1732.60	450.47	2183.07
Tecomastans	6.10	0.79	0.30	466	141.25	36.72	177.97
Peltophorumpterocarpum	18.30	3.20	14.92	602	8981.69	2335.24	11316.93
Bambusa vulgaris	11.92	0.21	0.04	600	25.11	6.53	31.64

Table 3. Total carbon stock, CO_2 eq. and Net O_2 release of the selected tree species in Coimbatore city

Scientific Name	Total biomass (kg $tree^{-1}$)	Carbon stock (kg $tree^{-1}$)	CO_2 (eq.) (kg $tree^{-1}$)	Net carbon sequestration (kg $tree^{-1}$ $year^{-1}$)	Net carbon sequestration (ton $tree^{-1}$ $year^{-1}$)	Net O_2 release (kg $tree^{-1}$ $year^{-1}$)	Net O_2 release (ton $tree^{-1}$ $year^{-1}$)
Spathodeacampanulata	233.642	116.821	428.266	47.59	126.862	0.127	233.642

Scientific Name	Total biomass (kg tree^{-1})	Carbon stock (kg tree^{-1})	CO_2 (eq.) (kg tree^{-1})	Net carbon sequestration (kg tree^{-1} year^{-1})	Net carbon sequestration (ton tree^{-1} year^{-1})	Net O_2 release (kg tree^{-1} year^{-1})	Net O_2 release (ton tree^{-1} year^{-1})
Terminalia arjuna	55.645	27.822	101.997	12.75	33.990	0.034	55.645
Clusiarosea	25.325	12.662	46.421	6.63	17.680	0.018	25.325
Parkiabiglandulosa	14154.945	7077.472	25946.013	720.72	1921.446	1.921	14154.945
Terminaliabellirica	459.676	229.838	842.585	76.60	204.212	0.204	459.676
Paubrasiliaechinate	939.973	469.987	1722.971	132.54	353.342	0.353	939.973
Madhucalongifolia	378.795	189.397	694.331	69.43	185.109	0.185	378.795
Couroupitaguianensis	5231.094	2615.547	9588.595	213.08	568.071	0.568	5231.094
Casuarinaequisetifolia	439.349	219.674	805.326	80.53	214.700	0.215	439.349
Phoenix pusilla	522.807	261.403	958.305	95.83	255.484	0.255	522.807
Ficusracemosa	1331.798	665.899	2441.185	195.29	520.656	0.521	1331.798
Cocos nucifera	826.934	413.467	1515.770	79.78	212.686	0.213	826.934
Lagunariapatersonia	523.858	261.929	960.231	76.82	204.798	0.205	523.858
Tabebuiaheterophylla	2768.498	1384.249	5074.657	289.98	773.088	0.773	2768.498
Bergerakoenigii	145.693	72.846	267.055	26.71	71.197	0.071	145.693
Acacia auriculiformis	4795.939	2397.969	8790.956	204.44	545.039	0.545	4795.939
Polyalthialongifolia	830.921	415.460	1523.077	29.01	77.343	0.077	830.921
Caryotamitis	24.617	12.308	45.123	4.10	10.936	0.011	24.617
Cordiasebestena	204.019	102.010	373.967	57.53	153.384	0.153	204.019
Cassia fistula	719.891	359.945	1319.560	188.51	502.564	0.503	719.891
Phyllanthusemblica	1236.827	618.414	2267.104	206.10	549.464	0.549	1236.827
Psidiumguajava	302.641	151.321	554.742	85.34	227.529	0.228	302.641
Terminaliacatappa	188.231	94.115	345.027	38.34	102.205	0.102	188.231
Malpighiaemarginata	19.571	9.785	35.873	5.52	14.714	0.015	19.571
Millingtoniahortensis	1440.846	720.423	2641.071	211.29	563.288	0.563	1440.846
Albizialebbeck	32296.703	16148.351	59199.856	1029.56	2744.814	2.745	32296.703

Scientific Name	Total biomass (kg tree^{-1})	Carbon stock (kg tree^{-1})	CO_2 (eq.) (kg tree^{-1})	Net carbon sequestration (kg tree^{-1} year^{-1})	Net carbon sequestration (ton tree^{-1} year^{-1})	Net O_2 release (kg tree^{-1} year^{-1})	Net O_2 release (ton tree^{-1} year^{-1})
Thespesiapopulnea	792.058	396.029	1451.842	223.36	595.479	0.595	792.058
Syzygiumcumini	2339.528	1169.764	4288.355	190.59	508.122	0.508	2339.528
Pterospermumacerifolium	4652.012	2326.006	8527.137	310.08	826.667	0.827	4652.012
Mangiferaindica	442.085	221.043	810.342	46.31	123.450	0.123	442.085
Delonixregia	11559.992	5779.996	21189.465	385.26	1027.111	1.027	11559.992
Hippocrateavolubilis	363.697	181.849	666.657	49.38	131.652	0.132	363.697
Morindatinctoria	337.836	168.918	619.252	68.81	183.436	0.183	337.836
Morus spp.	564.989	282.495	1035.625	94.15	250.998	0.251	564.989
Azadirachtaindica	7405.904	3702.952	13575.022	301.67	804.245	0.804	7405.904
Araucaria heterophylla	49.055	24.527	89.918	9.99	26.636	0.027	49.055
Simaroubaglauca	718.404	359.202	1316.834	119.71	319.153	0.319	718.404
Nyctanthes arbor-tristis	20.746	10.373	38.027	5.85	15.597	0.016	20.746
Paulownia tomentosa	501.145	250.572	918.599	141.32	376.767	0.377	501.145
Millettiapinnata	1725.709	862.854	3163.224	140.59	374.807	0.375	1725.709
Bauhinia purpurea	477.907	238.953	876.003	70.08	186.834	0.187	477.907
Gliricidiasepium	375.503	187.752	688.298	21.18	56.462	0.056	375.503
Leucaenaleucocephala	2396.389	1198.194	4392.581	313.76	836.473	0.836	2396.389
Roystonearegia	1695.761	847.881	3108.330	138.15	368.303	0.368	1695.761
Ficusreligiosa	6488.668	3244.334	11893.728	339.82	905.962	0.906	6488.668
Santalum album	135.182	67.591	247.789	14.16	37.749	0.038	135.182
Manilkarazapota	21.023	10.512	38.536	5.93	15.806	0.016	21.023
Kigelia Africana	8774.071	4387.036	16082.873	378.42	1008.869	1.009	8774.071
Mimusopselengi	1881.720	940.860	3449.192	125.43	334.383	0.334	1881.720
Tamarindusindica	24268.032	12134.016	44483.303	808.79	2156.227	2.156	24268.032
Tectonagrandis	1834.173	917.086	3362.039	149.42	398.364	0.398	1834.173

Scientific Name	Total biomass (kg tree^{-1})	Carbon stock (kg tree^{-1})	CO_2 (eq.) (kg tree^{-1})	Net carbon sequestration (kg tree^{-1} year^{-1})	Net carbon sequestration (ton tree^{-1} year^{-1})	Net O_2 release (kg tree^{-1} year^{-1})	Net O_2 release (ton tree^{-1} year^{-1})
Tipuanatipu	1006.718	503.359	1845.313	136.69	364.415	0.364	1006.718
Ficusbenjamina	1602.770	801.385	2937.878	178.05	474.690	0.475	1602.770
Sterculiafoetida	1051.551	525.775	1927.493	116.82	311.436	0.311	1051.551
Limoniaacidissima	2183.070	1091.535	4001.567	106.71	284.485	0.284	2183.070
Tecomastans	177.972	88.986	326.222	50.19	133.801	0.134	177.972
Peltophorumpterocarpum	11316.925	5658.463	20743.924	377.16	1005.515	1.006	11316.925
Bambusa vulgaris	31.641	15.820	57.998	5.80	15.462	0.015	31.641

3.4 Correlation between DBH and carbon stock, Carbon dioxide eq. and Net oxygen release of selected tree species

The significant correlations and trends that have been identified in this study (Figure 5 and Figure 6). The DBH, age and height of the tree are the important factors that determine carbon sequestration and oxygen production. The correlation relationship between DBH and carbon stock was analysed (Figure 5). The results showed a positive correlation of R^2 (0.81434) with a gradient of 2533.66 showing a strong relationship between DBH and Carbon stock. The relationship between Carbon dioxide (eq.) and Net oxygen release was also analysed (Figure 6). The results showed a strong positive correlation of R^2 (0.89521) with a gradient of 0.046.

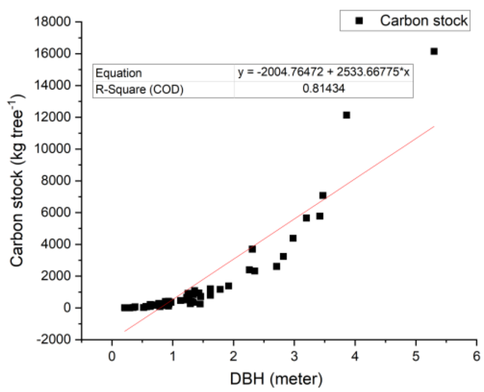

Fig. 5. Correlation coefficient (r^2 value) between DBH and Carbon stock of selected tree species

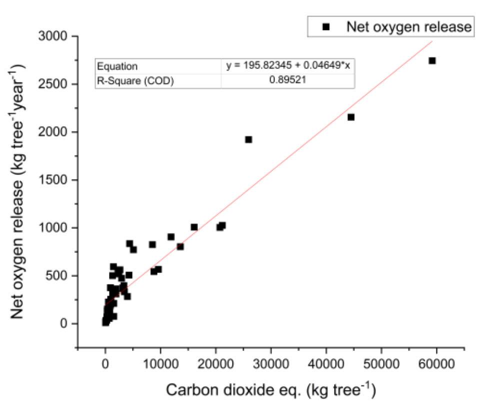

Fig. 6. Correlation coefficient (r^2 value) between Carbon dioxide eq. and Net oxygen release of selected tree species

4. CONCLUSION

The present study confirms that species with higher biomass, resulted in high carbon sequestration and high oxygen release. Among 58 tree species evaluated, Fabaceae species were abundant, with larger tree volumes, biomass, carbon stocks resulting in high net carbon sequestration and net oxygen release. Similarly, growth of *Albizialebbeck* was noticeably supreme when compared to others, followed by *Tamarindusindica*, *Parkiabiglandulosa*, *Delonixregia*, *Kigelia Africana*, *Peltophorumpterocarpum*, *Ficusreligiosa*, *Leucaenaleucocephala*, *Pterospermumacerifolium* and *Azadirachtaindica.* Green cover development projects with the above-mentioned trees could improve the carbon capture, oxygen release and air quality of Coimbatore city. In order to improve air quality along with substantial economic benefits in urban areas, appropriate number of trees, age of planting and spacing must be ascertained in future studies.

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