

# CO<sub>2</sub> Assimilation Rates of *Polyathia longifolia* and *Terminalia ivorensis* in Sokoto State Nigeria

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This study aimed to examine the rates of CO<sub>2</sub> assimilation of *Polyathia longifolia* and *Terminalia ivorensis* in Sokoto State Nigeria. Data for this research was obtained from seven-year-old, even-aged stands in the study area. Haga Hypsometer and Relascope were used to measure tree diameter and heights. Formula was used to measure the amount of carbon captured by the sampled species. The data obtained was analyzed testing for significant differences in assimilated CO<sub>2</sub> using Graphpad prism. However, the results showed that, *P. longifolia* assimilated and stored more CO<sub>2</sub> than *T. ivorensis* (0.084; 0.050 and 0.023; 0.014) metric tonnes which is attributed to the differences in growth features, such as bole of the trees, rooting system, branching pattern and leaf size. In view of this, *P. longifolia* was recommended for urban landscaping that are designed specifically for high carbon dioxide assimilation in industrialized districts, underground water release and shade to ameliorate local climate and reduce warming.

Keywords: Assimilation, Carbon, Carbon dioxide, Landscape, Even-aged

## 1. Introduction

Forests play a major importance in mitigating change of the climate by reducing the greenhouse gas CO<sub>2</sub> and storing the carbon in wood trunks thereby keeping earth free from overheating. About 1/4 of the global surface is filled with forests (tropical, boreal, temperate). Though scientists know that plants absorb CO<sub>2</sub>, they are not sure how important their role was. For example, how much carbon sequestration is due to tropical forests and what is the contribution of various species to carbon harvesting has not been investigated and documented [1]. What specific amount of CO<sub>2</sub> gas is sequestered and emptied out by agro-forestry plants need to be studied since land hunger for development and production of human needs is increasing daily, plants in our environment suffer.

Carbon sequestration could be defined as the forceful uptake or capture of CO<sub>2</sub> (CO<sub>2</sub>) from free molecules in the atmosphere by green plant for the process of carbohydrate production. The pace of carbon sequestration relies upon the development attributes of the plant species (Internal), the circumstances for development where the plant is planted (External), and the thickness of the plant's wood (Internal). It is most noteworthy in the more youthful phases of plant development, between 20-50 years. [1,2] Carbon take-up by forestation is one strategy proposed to decrease net CO<sub>2</sub> outflows to the environment thus limit the radiative compelling of environmental change [3]. It has been accounted for that tropical plants represent 95% of plant-put together carbon catch with respect to our earth and presented species (extraordinary) eliminate more carbon than native species [4].

Tropical timberlands immaculate by deforestation ingest and hold immense measures of carbon in their biomass and soil [5,6]. Studies have figured out that shockingly a lot of carbon get consumed by re-development of tropical timberlands recuperating from the deforestation. It is hard to design any land use change that would considerably alleviate proceeded with expansion in environmental CO<sub>2</sub> level without including timberlands. CO<sub>2</sub> has increased from petroleum derivative use in transportation, apartment heating and cooling and the production of concrete and other merchandise. Deforestation emit CO<sub>2</sub> and reduces its take-up by plants. CO<sub>2</sub> also delivered in regular cycles. CO<sub>2</sub> is the fundamental hotness catching gas generally liable for the majority of the normal warming throughout recent many years [7]. Less examination has been done on tropical plant species when contrasted with calm plant species. An examination on the impact of individual tropical plant species on woodland Carbon balance is ideal since late backwoods estates are planted as monocultures.

Photosynthesis is impacted by two classes of elements - outside or ecological and inward or plant factors. How much light (force and term), the CO<sub>2</sub> supply, temperature, supply of water, and the availability of minerals are the major ecological variables that impact the pace of photosynthesis in trees.

*Polyalthia longifolia* is an Asian plant species in the family of Annonaceae. It is native to India, but has been widely introduced to Africa and the tropics [8]. It is locally known as “Masquerade Plant” in Nigeria. In northern Nigeria it has been used both as shade plant and splantt beautification when allowed to grow into a large plant. *Terminalia ivorensis* belongs to the family Combretaceae. It is a deciduous commonly found in the rainforest vegetation zone in tropical Africa. In the peak of the dry season, it sheds off its leaves in order to retain moisture and new leaves emerge at the onset of the rainy season. *Terminalia ivorensis* is planted in numerous tropical nations as a promising lumber manor animal groups, for example in Senegal, Uganda, Tanzania, India, Malaysia, and Brazil [9], yet has as of late observed its place as overhanging plant (umbrella plant) in unban urban communities as a shade for coating roads, stops and homes. The plants grow up to 45-50m tall, the root foundation for the most part comprising of a taproot and a few in number shallow sidelong roots; the bole is branchless for up to 30-35m, typically straight and barrel shaped, yet entirely regularly somewhat fluted or precise close to the base. The width ultimately depends on 120-170cm in some cases with little and thick braces up to 1 m high [10].

## 2. Methodology

Nigeria falls within the tropical region of sub-Saharan Africa and the north western region of the country comprises of Sokoto, Kebbi, Zamfara and Niger states. The study area is located within the main town of Sokoto. The area has previously been used as farmlands for the predominantly agrarian population for growing millet, sorghum and guinea corn. It is situated within latitudes 13° 2' 16" North, and 5° 5' 37" East, the rainfall and temperature pattern is similar to that prevalent in the tropical Sudan savannah with seasonal high sometimes exceeding 48°C. The relative humidity is very low and dry wind with sand storm is common. [11].

### 2.1. Tree Sampling and Data collection

Data collection materials such as Haga Hypsometer, Relascope, Distance measuring and diameter tapes, were used in this study. *P. longifolia* and *T. ivorensis* was planted in April – May 2014. For the purpose of this research, all trees lining the boulevard (100% of trees) were sampled.

### 2.2. Data Analysis

The over all weight of green plant, carbon weight in the plant; dry weight of the plant and the weight of CO<sub>2</sub> assimilated by the plants were determined using the process explained below:



Figure 1: Areal image showing the study area

### 2.3. For calculating the overall (green) weight of the plant

The algorithm is depend on Southeast United States plants. The algorithm is to measure the weight of a plant is:

$$W = 0.25D^2H$$

Where:

W = Above-ground plant weight in pounds

D = Trunk diameter in inches

H = Plant height in feet

Note: The root system weighs around 20% over the ground plant weight of. Thusly, to decide the complete green load of the plant, duplicate the over the ground weight of the plant by 120%. To assess the dry load of the plants, a transformation factor 0.0725 was utilized to duplicate the absolute green weight,

Determining the weight of carbon in the plant

$$Wc = \frac{Wd}{2} \quad \text{Where: } Wc = \text{weight of Carbon; and } Wd = \text{Dry weight of the plant.}$$

Determining the weight of CO<sub>2</sub> sequestered in the plant

To measure the weight of CO<sub>2</sub> sequestered in the plant, multiply the weight of carbon in the plant:

$$Wco = 3.6663 Wc$$

Since the ratio of C to O<sub>2</sub> in CO<sub>2</sub> is  $\frac{43.999915}{12.001115} = 3.6663$ . [12, 13]

### 3. Results

Result from the table 1 and 2 below shows that was no significant difference at  $P < 0.05\%$  between stem diameters of *Polyalthia longifolia* and *Terminalia ivorensis* trees, seven years after planting out to the field. However, there were significant difference between tree mean height, mean carbon dioxide assimilation rates and mean carbon stored in boles of *Polyalthia longifolia* than *Terminalia ivorensis*. *Polyalthia longifolia* has better mean height (6.57; 5.28), carbon dioxide assimilation rate (0.084; 0.050) and carbon stored in tree bole (0.023; 0.014) than *Terminalia ivorensis*.

Table 1: Diameter at breast height (m) and height (m) of the two species		
Species		Sig (P < 0.05)
P. longifolia	T. ivorensis	

Height (m)	6.57a	5.28b	***
Std error	0.20	0.19	
Diameter (m)	0.18	0.15	Ns
Std Error	0.003	0.007	

Mean in the same row followed by the same letter do not significantly differ from each other ( $P < 0.05$ , Bonferroni's multiple comparison test).

Table 2: CO<sub>2</sub> assimilation rates (metric tonnes) of the two species

	Species		Sig. ( $P < 0.05$ )
	<i>P. longifolia</i>	<i>T. ivorensis</i>	
CO <sub>2</sub> assimilation (tonnes)	0.084a	0.050b	***
Std Error	0.006	0.006	
Carbon stored (tonnes)	0.023a	0.014b	*
Std Error	0.0015	0.0016	

Mean in the same row followed by the same letter do not significantly differ from each other ( $P < 0.05$ , Bonferroni's multiple comparison test).

#### 4. Discussion

This carbon sequestration result of *T. ivorensis* (0.014tonnes/tree) does not agree with [14] **while** the result of *P. longifolia* (0.023tonnes/tree) is similar to that reported by [14] in his work that tropical climates support the sequestration of atmospheric carbon dioxide at an average of 0.025tonnes of carbon dioxide per tree per year, **while** measurements show that there are significant difference in carbon dioxide assimilation between *P. longifolia* and *T. ivorensis* growing in a similar habitat. The present findings are in line with the report of [15] which states that phylogenetic relatedness and growth form and are important predictors of carbon assimilation rates. The morphological and anatomical variations between the leaves of the two species as observed by [16] could be a factor for the significant difference in carbon dioxide assimilation between the species. The shape and size of the leaves differ, hence the area of leaf and stomata opening available to influx of carbon dioxide would differ in the trees. However, since the two tree species are growing in the same field under similar solar light intensity, solar exposure may not be a determinant factor of their carbon dioxide assimilation and storage.

#### 5. Conclusion and Recommendations

The study revealed that the rate of CO<sub>2</sub> assimilation and storage varies in the species studied. The rate of CO<sub>2</sub> sequestration is higher in *P. longifolia* and could be recommended as tree for use in open urban landscapes for aesthetic planting which could help to ameliorate the local climate; as well as reduce atmospheric CO<sub>2</sub> released from industrial and mobile combustion. *T. ivorensis* has a wider canopy than *P. longifolia*, thus could be used in situations where a large range needs to be covered. Further studies on urban landscaping trees for carbon dioxide assimilation, underground water release and shade to ameliorate local climate and reduce warming is required to determine trees suitability for urban landscaping.

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