Journal of Global Ecology and Environment

Volume 20, Issue 4, Page 102-114, 2024; Article no.JOGEE.12478
ISSN: 2454-2644

Assessment of Biomass, Carbon Stock and Sequestered CO_2 in Teak (*Tectona grandis* L.*f*.) Plantation at Pt. Ravishankar Shukla University Campus, Raipur, Chhattisgarh, India

Sarvesh Kaushik Patel [a*] and M. L. Naik [b]

[a] *Department of Botany, Government Rajeev Lochan Post Graduate College, Rajim, Chhattisgarh, 493885, India.*
[b] *Forest and Climate Change Department, Chhattisgarh State Biodiversity Board, Government of Chhattisgarh, Atal Nagar-Nava Raipur, Chhattisgarh, 492001, India.*

Authors' contributions

This work was carried out in collaboration between both authors. Author SKP designed the study, performed the statistical analysis, and wrote the first draft of the manuscript. Author MLN managed the literature searches, wrote the protocol, and analyses of the study. Both authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.56557/jogee/2024/v20i48915

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://prh.ikprress.org/review-history/12478

Original Research Article

Received: 15/08/2024
Accepted: 19/10/2024
Published: 24/10/2024

ABSTRACT

Carbon sequestration through tree plantation has significant role to mitigate the increasing level of CO_2. Accurate measurement of carbon in teak plantations is required for estimating their contribution to global carbon stocks. The purpose of present work was to assess total biomass,

---

**Corresponding author: E-mail: somusdna@gmail.com;*

Cite as: *Patel, Sarvesh Kaushik, and M. L. Naik. 2024. "Assessment of Biomass, Carbon Stock and Sequestered CO2 in Teak (Tectona Grandis L.F.) Plantation at Pt. Ravishankar Shukla University Campus, Raipur, Chhattisgarh, India". Journal of Global Ecology and Environment 20 (4):102-14. https://doi.org/10.56557/jogee/2024/v20i48915.*

carbon stock and sequestered CO_2 in an 18 years old teak (*Tectona grandis* L. *f.*) plantation using allometric equations. Estimated total biomass, carbon stock and sequestered CO_2 were 79.31, 37.28 and 136.66 t ha^{-1}, respectively. Teak plantations in Chhattisgarh serve an important role in carbon sequestration, which contributes to climate change mitigation. It is a fast-growing species with robust, high-carbon wood, accumulates a substantial quantity of carbon over time. Expanding and sustaining these plants reduces atmospheric CO_2 levels while also benefiting the region's economy through timber production and forest-based livelihoods.

Keywords: Biomass; carbon sequestration; carbon stock; teak plantation; Tectona grandis.

1. INTRODUCTION

Climate change has been at the very center of several global agreements since the 1980s. India has pledged to decrease overall anticipated carbon emissions by up to 1 billion tones by 2030, in addition to other aggressive climate change targets agreed upon at the recent COP26 meeting in Glasgow. Forest ecosystems play an important role in carbon sequestration by absorbing CO_2 from the atmosphere and storing it in biomass and soil. Plantations of rapidly maturing species such as teak (*Tectona grandis*) get special attention for their ability to trap significant amount of carbon in a short period of time.

Teak, a native of south and southeast Asia, is known for its high-quality timber and fast growth, making it a popular species for commercial forestry. Teak plantations not only give economic benefits through timber production, but they also help to maintain ecological stability by increasing biodiversity, reducing soil erosion, and sequestering carbon. According to the India State of Forest Report [1], India has been proactively expanding its forest cover through forest restoration and afforestation activities, in which teak plays a significant role. Determining the biomass accumulation and carbon storage capacity of these plantations gives us idea, how much helpful these plantations will be in reducing the CO_2 from the atmosphere.

Biomass is the organic matter derived directly or indirectly starting through photosynthesis with minor contribution through chemosynthesis also. Thus, the biomass includes all the living or dead matter of plant or animal biomass, it is commonly referred as dry biomass. It may be expressed as $organism^{-1}$ or in unit $area^{-1}$. The biomass of different ecosystems varies significantly depending on its location, succession, species composition, and level of disturbance [2]. Forest plantations significantly impact the global carbon sink, and the ability of tree species to store carbon is mostly dictated by the clone type and rotation age of their plantations, which control biomass production [3]. Recent studies carried out in central India [4] have highlighted the importance of teak plantations in global carbon budget, and its enormous carbon sequestration potential of teak. These workers have also observed that mature teak plantations might store up to 200 t ha^{-1} of carbon. Similarly, Basu et al. [5] also have found that teak plantations are good at capturing and storing atmospheric carbon, playing an important role in regional carbon dynamics.

The present study aims to make further contribution towards the assessment of biomass, carbon stock and sequestered CO_2 in a teak plantation in Chhattisgarh state, representing truly the central India. The present study will acts as beginning to quantify the total biomass of individual trees, estimate the total carbon stock and amount of sequestered CO_2 in per unit area, which will bring out the significance of teak plantations being made in Chhattisgarh state starting since more than 75 years ago. The state also boasts to have the historic teak plantation made by Maniram Nishad.

2. MATERIALS AND METHODS

2.1 Study Area

The study was conducted in the teak plantation behind the Vice-Chancellor's bungalow of Pt. Ravishankar Shukla University, Raipur, Chhattisgarh at coordinates 21.2458838° N and 81.598534° E. (Fig. 1). The teak plantation covers an area of 2317.25 m^2 or ≈0.232 ha (Fig. 2), was made in 2006 and was cared for successful growth by Dr. Ashok Pradhan (Professor, SoS in Anthropology).

The annual temperature in Raipur ranges from a low of around 10°C in winter to highs exceeding

45°C in summer. The city receives an average annual rainfall of around 1300 mm, primarily concentrated in the monsoon months, from mid-June to mid-September. Humidity levels vary greatly throughout the year, with high humidity during the monsoon and low humidity during the summer and winter months.

2.2 Sampling Design

A stratified random sampling method was employed to ensure representative sampling across different tree sizes within the plantation. All standing teak with a Circumference at Breast Height (CBH) ≥ 3 cm.

2.3 Data Collection

Measurement and calculation of tree parameters: Circumference at Breast Height (CBH) was measured using a meter tape at 1.37 m above from ground level of the 210 individuals in the month of May 2024. Diameter at Breast Height (DBH) was calculated using following formula [6]:

$$DBH = \frac{CBH}{\pi}$$

Where, CBH is Circumference at Breast Height and π = 3.14.

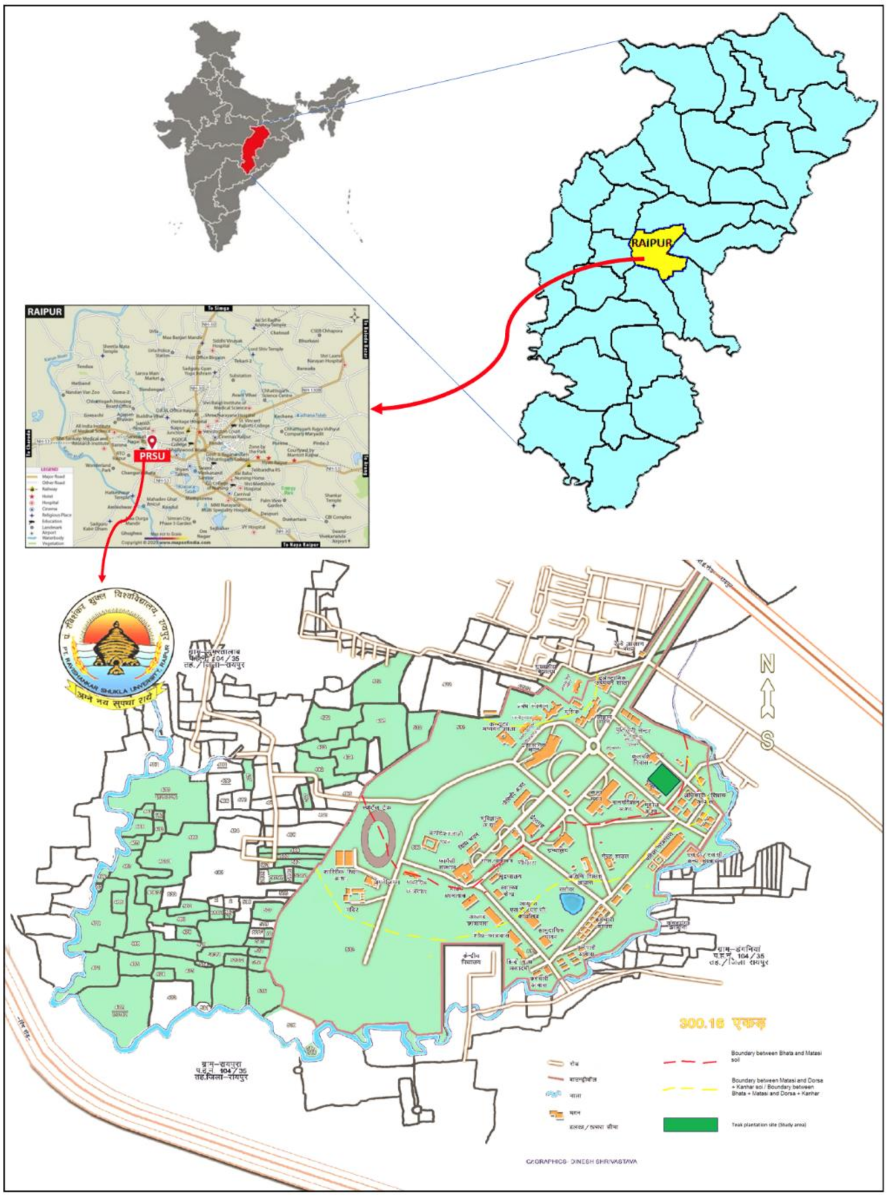

Fig. 1. Location map of study area (Teak plantation) at Pt RSU campus, Raipur

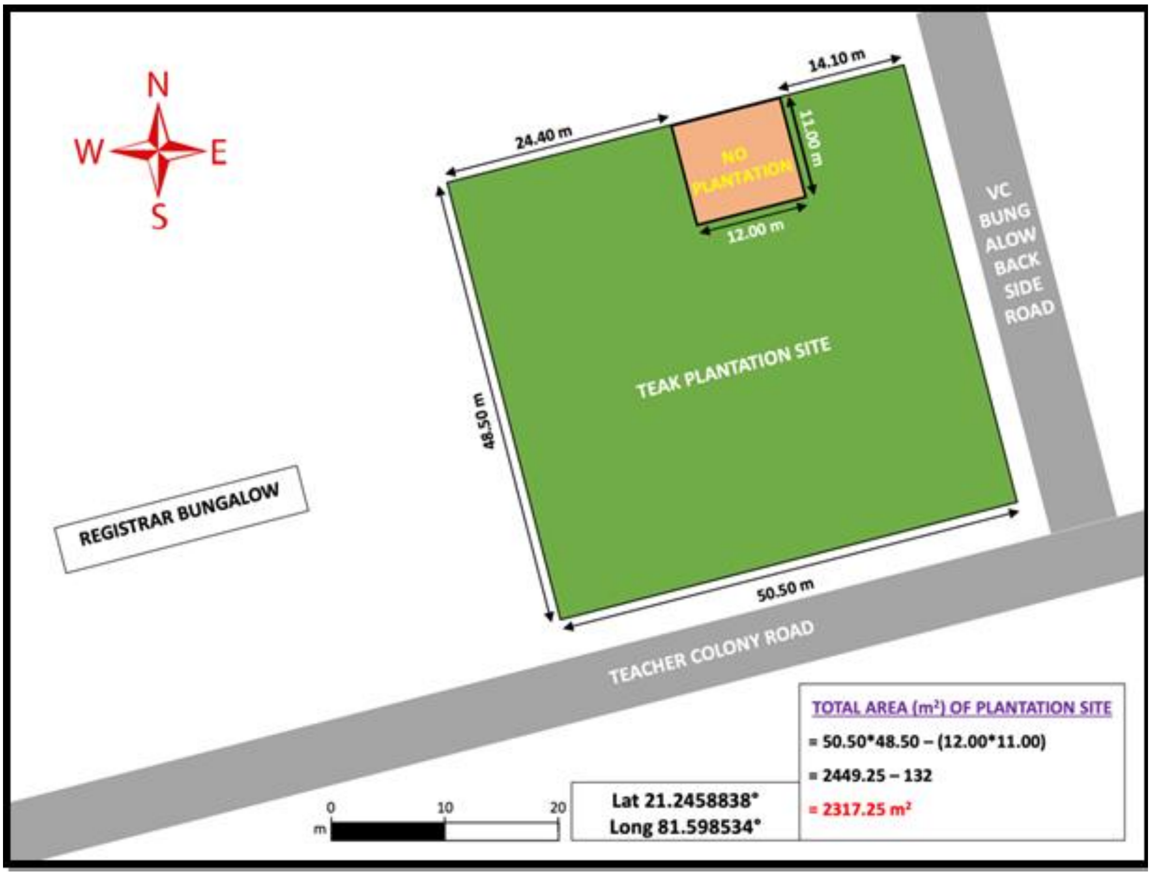

Fig. 2. Layout of Teak plantation site at Pt Ravishankar Shukla University, Raipur

Estimation of total biomass: The total biomass (kg) for each tree was calculated by using derived allometric equation by Sharma and Naik [7]. Following two allometric equations were derived for different DBH range:

DBH range (cm)	Equation	R^2 (% of variation)
2.0-6.9	$Y = -3.6604 + 1.9285\,X$	89.17
7.1-27.1	$Y = 21.9275 - 5.8173\,X + 0.6255\,X^2$	99.00

Estimation of carbon stock: Teak plants store 47% of their biomass as carbon, which can be estimated using known biomass values [8]. The findings of total biomass calculation can be converted into carbon stock (kg) by multiplying the biomass value by a conversion ratio of 0.47. To estimate carbon stocks using formula:

$$C = 0.47 \times B$$

Where, *B* is the total biomass (kg).

Estimation of Sequestered CO_2: To convert carbon stock to CO_2, the molecular weight ratio of CO_2 and C has been used, which is approximately 3.67 (since CO_2 is about 44/12 times heavier than C).

$$\text{Sequestered } CO_2 = C \times 3.67$$

Where, *C* is the Carbon stock (kg).

Plantation-level estimations: Overall carbon stock was computed by summation of the carbon stock of each individual tree in the plantation. The carbon stock ha^{-1} were then extrapolated across the plantation area.

2.4 Data Analysis

The collected data were analyzed using MS Excel to calculate all the above things for biomass and carbon stock estimates. Regression analysis was performed to refine the allometric equations. Hex bin plot was generated with the help of R.

3. RESULTS AND DISCUSSION

Total biomass: The DBH of 210 sampled trees of 18 years old plantation varied from 3.24 to

34.78 cm. This variation in the total biomass of trees, which varied between 2.58 and 572.74 kg tree^{-1} (Table 3). Mean value found to be 87.62 kg with a standard deviation (SD) of 81.68 kg and standard error (SE) 5.64 (Table 1, Fig. 4). Maximum biomass of 572.74 kg was recorded in 34.78 cm DBH. Biomass increased with increase in DBH. The total biomass of *Tectona grandis* L.*f*. plantation was estimated 18.40 t or 79.31 t ha^{-1} (Table 1) with R^2 value of 0.9993. It means the regression model explains 99.93% of the variance in the dependent variable. This suggests that the model we derived practically accurately anticipates the dependent variable *Y* (Biomass) based on the independent variable *X* (DBH) (Table 2, Fig. 3). This plantation demonstrates significant variation in their biomass production within the same age groups.

Carbon stock: The carbon stock varies across all the sampled trees from 1.21 to 269.19 kg tree^{-1} (Table 3). Maximum carbon stock of 269.19 kg was recorded in 34.78 cm DBH. Total carbon stock was calculated 8.65 or 37.28 t ha^{-1} (Table 2). The mean carbon stock was found to be 41.18 kg with SD of 38.39 kg, indicating the variability in carbon stock within the individuals. The SE was 2.65, suggesting the precision of the mean estimate (Table 1, Fig. 4). The strong correlation between carbon stock and DBH is highlighted by the regression analysis, which shows that 99.93% of the variation in carbon stock (R^2 = 0.9993) is explained by DBH. Therefore, this indicates that the constructed equation accurately predicts carbon stock (*Y*) with DBH (*X*) as an independent variable. (Table 2, Fig. 3).

Sequestered CO_2: Among 210 trees in the sample, the sequestered CO_2 differs from 4.45 to 986.91 kg tree^{-1} (Table 3). Tree with 34.78 cm DBH, the maximum sequestration was calculated as 269.19 kg. Total sequestered CO_2 was observed 31.71 or 136.66 t ha^{-1} (Table 1). The sequestered CO_2 equation indicates a close relationship with DBH, and the mean sequestered CO_2 is 150.98 kg tree^{-1}. This parameter shows the highest variability, with a SD of 140.75 kg (SE 9.71) (Table 1, Fig. 4). This finding highlights the strong predictive power of DBH for estimating sequestered CO_2. Consequently, this suggests that the developed equation, which uses DBH (*X*) as an independent variable, correctly forecasts sequestered CO_2 (*Y*) (Table 2, Fig. 3). The high R^2 values (0.9993) for the derived equations indicate reliable models for sequestered CO_2.

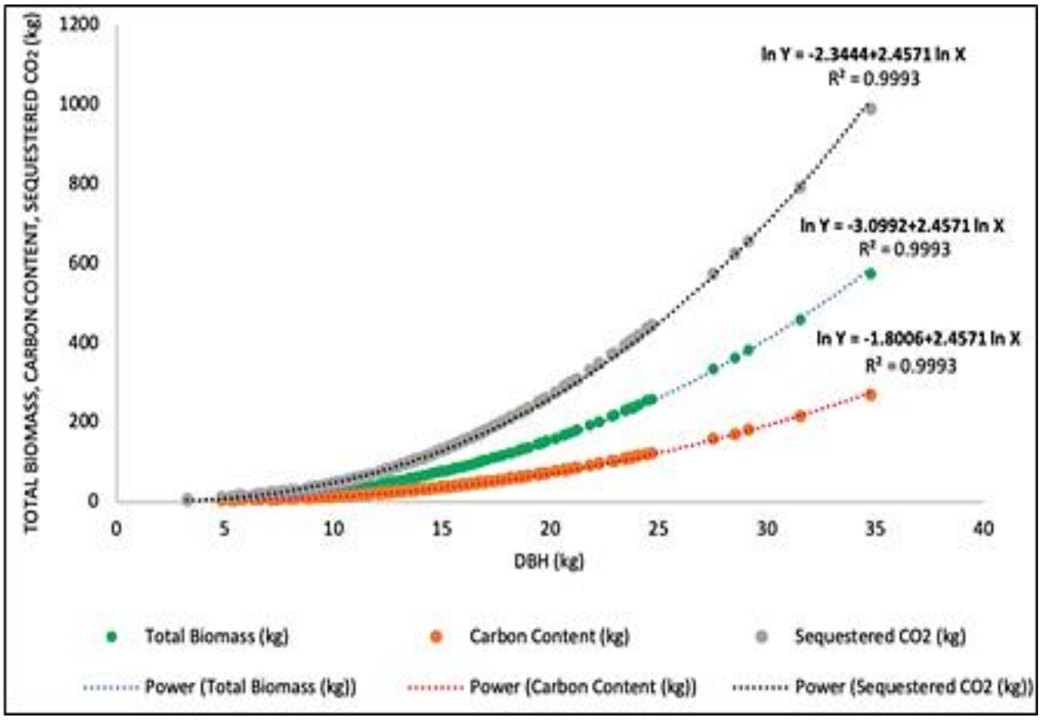

Fig. 3. Relationship between DBH and Total Biomass, Carbon Content & Sequestered CO_2

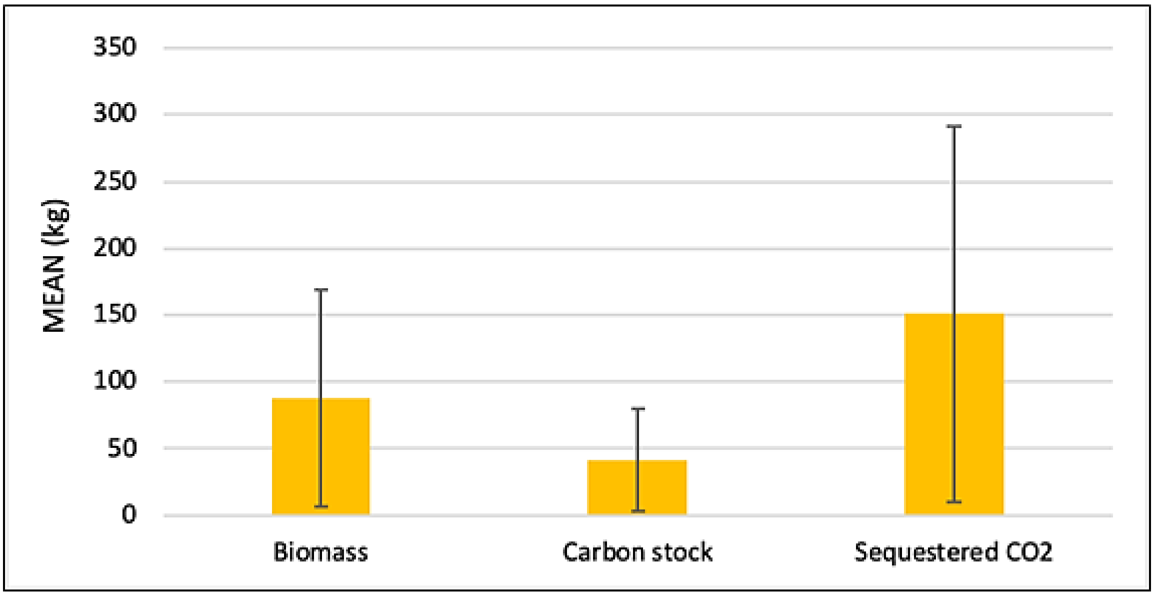

Fig. 4. Mean (kg) and standard deviation of Total Biomass, Carbon Content and Sequestered CO_2

Table 1. Calculated values of study area and extrapolated value per hectare for Teak sampled in May 2024

S. No.	Parameters	Calculated values of study area		Mean (kg) ± SD	SE	Extrapolated value ha^{-1} (t)
		(kg)	(t)			
1.	Total biomass	18400.24	18.40	87.62 ± 81.68	5.64	79.31
2.	Carbon stock	8648.11	8.65	41.18 ± 38.39	2.65	37.28
3.	Sequestered CO_2	31706.18	31.71	150.98 ± 140.75	9.71	136.66

Table 2. Equations and percent variation (R^2) for Teak sampled in the month of May 2024

S. No.	Parameters (kg)	DBH range (cm)	Equation derived (*Y*=Parameters, *X*=DBH)	R^2 (% of variation)
1.	Total biomass	3.24-34.78	$\ln Y = -2.3444 + 2.4571 \ln X$	99.93
2.	Carbon stock		$\ln Y = -3.0992 + 2.4571 \ln X$	
3.	Sequestered CO_2		$\ln Y = -1.8006 + 2.4571 \ln X$	

The hex bin plot illustrates the relationship between total biomass (kg) and DBH (cm). The color gradient represents the count of data points within each hexagon, with darker colors indicating higher densities. Most data points are concentrated around 10-20 cm DBH and 50-150 kg biomass, indicating a positive correlation. As the DBH increases, the variability in biomass also increases, with some trees showing significantly higher biomass. (Fig. 5). Within an 18-year-old plantation, the study demonstrates the notable variations in total biomass production, carbon stock, and sequestered CO_2. Through strong regression models, the association between these variables and the DBH is highlighted, indicating that DBH is a highly accurate indicator for these parameters. The measured total biomass range in this study represents a wide variation across the studied trees. This high association is consistent with previous studies like Chave et al. [9] in tropical forest trees, whereas Chaturvedi and Raghubanshi [10] in teak plantations in central India observed a similar relationship and Suresh et al*.* [11] revealed similar findings in which the biomass was closely connected to DBH. Their findings demonstrated that the biomass equations developed for *Tectona grandis* L.*f.* may accurately forecast tree biomass throughout various regions of India. The carbon stock values exhibit significant variability among individuals. The mean carbon stock of 41.18 kg, with a standard deviation of 38.39 kg, indicates this heterogeneity. The regression analysis for carbon stock reaffirms the strong dependency on DBH. This is in line with findings by Karmacharya and Singh [12] noted substantial relationships between DBH and carbon stock in teak in central India, demonstrating reliability of DBH as a predictor in a variety of forest management applications. The sequestered CO2 values varied widely reflecting the highest variability among the three parameters studied. The mean sequestered CO_2, SD and R^2 indicates that DBH is a robust predictor of CO_2 sequestration. This finding is corroborated by earlier study viz. Nowak and Crane [13], who highlighted the effectiveness of DBH in estimating urban tree carbon sequestration. Kishwan et al. [14] reported similar findings and emphasized teak plantations' relevance in carbon sequestration efforts in India. The strong R^2 values (0.9993 or 99.93%) for all the derived equations in present study highlight the resilience of DBH as a predictor for biomass, carbon stock, and sequestered CO_2 in teak (*Tectona grandis* L.*f.*) plantation. The great variability of these factors emphasizes the significance of adopting exact models to account for individual tree peculiarities.

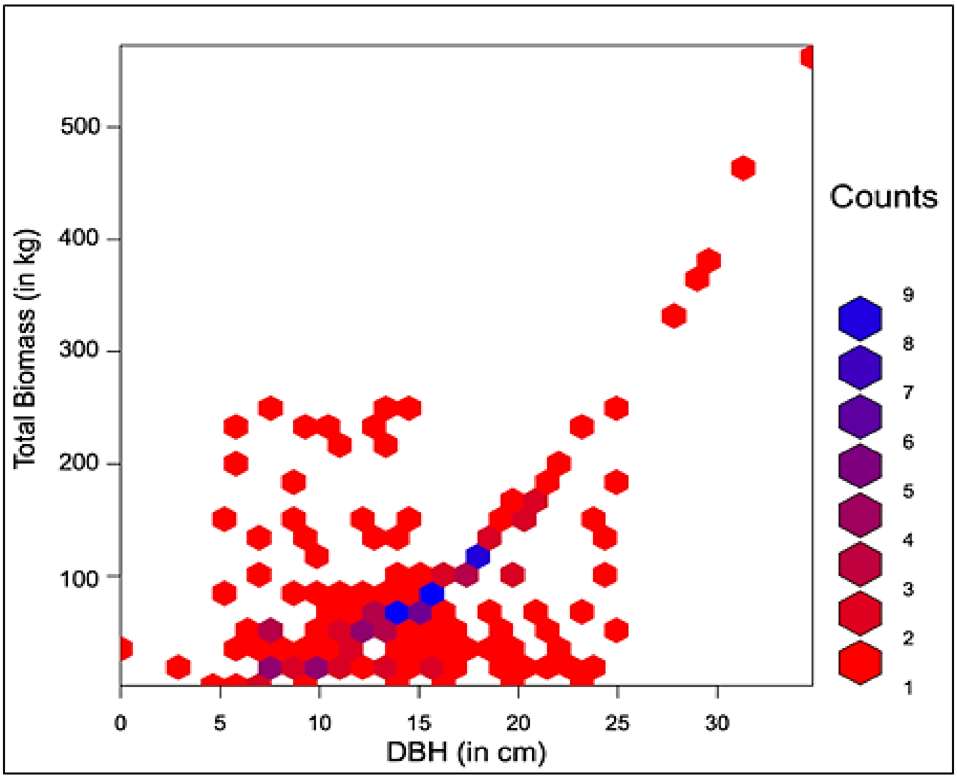

Fig. 5. Hex bin plot of Total Biomass (kg) VS DBH (cm)

Table 3. Measured and calculated values of different parameters for Teak (*Tectona grandis* L.*f.*) plantation at Pt. Ravishankar Shukla University, Raipur, Chhattisgarh, recorded in the month of May 2024

Tree No.	CBH* (cm)	DBH* (cm)	Total Biomass (kg)	Carbon Stock (kg)	Sequestered CO_2 (kg)
1	60.96	19.41	143.61	67.50	247.47
2	46.99	14.96	74.28	34.91	128.00
3	57.15	18.20	122.26	57.46	210.67
4	43.18	13.75	59.65	28.04	102.78
5	55.88	17.80	115.55	54.31	199.11
6	63.50	20.22	158.87	74.67	273.75

Tree No.	CBH* (cm)	DBH* (cm)	Total Biomass (kg)	Carbon Stock (kg)	Sequestered CO_2 (kg)
7	99.06	31.55	457.96	215.24	789.12
8	50.80	16.18	90.75	42.65	156.37
9	73.66	23.46	228.03	107.17	392.92
10	52.07	16.58	96.64	45.42	166.53
11	44.45	14.16	64.32	30.23	110.84
12	109.22	34.78	572.74	269.19	986.91
13	54.61	17.39	109.04	51.25	187.90
14	62.23	19.82	151.14	71.03	260.43
15	54.61	17.39	109.04	51.25	187.90
16	64.77	20.63	166.80	78.40	287.42
17	86.36	27.50	332.81	156.42	573.47
18	59.69	19.01	136.29	64.06	234.85
19	50.80	16.18	90.75	42.65	156.37
20	38.48	12.26	44.13	20.74	76.04
21	38.10	12.13	42.99	20.21	74.08
22	46.99	14.96	74.28	34.91	128.00
23	39.37	12.54	46.85	22.02	80.73
24	52.58	16.74	99.06	46.56	170.69
25	35.56	11.32	35.88	16.87	61.83
26	57.15	18.20	122.26	57.46	210.67
27	46.99	14.96	74.28	34.91	128.00
28	33.66	10.72	31.09	14.61	53.57
29	73.66	23.46	228.03	107.17	392.92
30	19.69	6.27	8.43	3.96	14.53
31	23.50	7.48	13.25	6.23	22.83
32	44.45	14.16	64.32	30.23	110.84
33	91.44	29.12	380.42	178.80	655.52
34	69.85	22.25	200.56	94.27	345.60
35	22.86	7.28	12.57	5.91	21.66
36	40.64	12.94	50.91	23.93	87.73
37	30.48	9.71	24.11	11.33	41.55
38	50.17	15.98	87.87	41.30	151.42
39	64.77	20.63	166.80	78.40	287.42
40	48.26	15.37	79.57	37.40	137.10
41	47.63	15.17	76.90	36.14	132.51
42	38.74	12.34	44.90	21.10	77.36
43	22.23	7.08	11.94	5.61	20.57
44	59.06	18.81	132.71	62.37	228.67
45	89.54	28.51	362.19	170.23	624.10
46	28.58	9.10	20.54	9.65	35.40
47	36.83	11.73	39.34	18.49	67.78
48	44.45	14.16	64.32	30.23	110.84
49	47.63	15.17	76.90	36.14	132.51
50	30.48	9.71	24.11	11.33	41.55
51	34.29	10.92	32.64	15.34	56.24
52	38.10	12.13	42.99	20.21	74.08
53	48.26	15.37	79.57	37.40	137.10
54	51.44	16.38	93.67	44.02	161.40
55	53.34	16.99	102.74	48.29	177.04
56	57.15	18.20	122.26	57.46	210.67
57	20.32	6.47	8.82	4.15	15.20
58	77.47	24.67	257.32	120.94	443.40
59	64.77	20.63	166.80	78.40	287.42
60	59.69	19.01	136.29	64.06	234.85
61	25.40	8.09	15.60	7.33	26.89

Tree No.	CBH* (cm)	DBH* (cm)	Total Biomass (kg)	Carbon Stock (kg)	Sequestered CO_2 (kg)
62	55.88	17.80	115.55	54.31	199.11
63	57.15	18.20	122.26	57.46	210.67
64	66.68	21.23	179.08	84.17	308.58
65	31.12	9.91	25.41	11.94	43.78
66	24.77	7.89	14.77	6.94	25.45
67	47.63	15.17	76.90	36.14	132.51
68	53.34	16.99	102.74	48.29	177.04
69	22.86	7.28	12.57	5.91	21.66
70	55.25	17.59	112.27	52.77	193.46
71	15.24	4.85	5.70	2.68	9.82
72	63.50	20.22	158.87	74.67	273.75
73	48.26	15.37	79.57	37.40	137.10
74	40.64	12.94	50.91	23.93	87.73
75	43.18	13.75	59.65	28.04	102.78
76	57.15	18.20	122.26	57.46	210.67
77	43.18	13.75	59.65	28.04	102.78
78	39.37	12.54	46.85	22.02	80.73
79	31.80	10.13	26.86	12.62	46.29
80	31.75	10.11	26.75	12.57	46.10
81	74.30	23.66	232.78	109.41	401.12
82	39.37	12.54	46.85	22.02	80.73
83	50.17	15.98	87.87	41.30	151.42
84	41.28	13.14	53.02	24.92	91.36
85	32.39	10.31	28.15	13.23	48.50
86	46.99	14.96	74.28	34.91	128.00
87	42.55	13.55	57.39	26.97	98.89
88	58.42	18.61	129.17	60.71	222.59
89	38.86	12.38	45.28	21.28	78.03
90	34.29	10.92	32.64	15.34	56.24
91	50.17	15.98	87.87	41.30	151.42
92	28.58	9.10	20.54	9.65	35.40
93	42.55	13.55	57.39	26.97	98.89
94	49.02	15.61	82.83	38.93	142.73
95	50.17	15.98	87.87	41.30	151.42
96	48.90	15.57	82.28	38.67	141.79
97	46.99	14.96	74.28	34.91	128.00
98	31.12	9.91	25.41	11.94	43.78
99	25.72	8.19	16.04	7.54	27.64
100	44.45	14.16	64.32	30.23	110.84
101	45.09	14.36	66.74	31.37	115.00
102	36.20	11.53	37.58	17.66	64.76
103	60.96	19.41	143.61	67.50	247.47
104	39.37	12.54	46.85	22.02	80.73
105	24.77	7.89	14.77	6.94	25.45
106	27.62	8.80	18.93	8.90	32.61
107	49.53	15.77	85.05	39.98	146.56
108	17.15	5.46	6.87	3.23	11.84
109	52.71	16.79	99.67	46.84	171.74
110	61.60	19.62	147.35	69.25	253.90
111	45.72	14.56	69.20	32.52	119.24
112	40.01	12.74	48.86	22.96	84.19
113	68.58	21.84	191.82	90.15	330.53
114	27.31	8.70	18.41	8.65	31.73
115	10.16	3.24	2.58	1.21	4.44
116	27.94	8.90	19.45	9.14	33.52

Tree No.	CBH* (cm)	DBH* (cm)	Total Biomass (kg)	Carbon Stock (kg)	Sequestered CO_2 (kg)
117	49.53	15.77	85.05	39.98	146.56
118	40.64	12.94	50.91	23.93	87.73
119	36.20	11.53	37.58	17.66	64.76
120	43.18	13.75	59.65	28.04	102.78
121	53.34	16.99	102.74	48.29	177.04
122	74.93	23.86	237.59	111.67	409.40
123	33.02	10.52	29.59	13.91	50.99
124	38.10	12.13	42.99	20.21	74.08
125	22.86	7.28	12.57	5.91	21.66
126	34.29	10.92	32.64	15.34	56.24
127	49.53	15.77	85.05	39.98	146.56
128	29.21	9.30	21.68	10.19	37.36
129	26.04	8.29	16.49	7.75	28.41
130	61.60	19.62	147.35	69.25	253.90
131	27.94	8.90	19.45	9.14	33.52
132	71.76	22.85	214.07	100.61	368.87
133	40.64	12.94	50.91	23.93	87.73
134	42.55	13.55	57.39	26.97	98.89
135	45.72	14.56	69.20	32.52	119.24
136	72.07	22.95	216.36	101.69	372.82
137	33.34	10.62	30.33	14.26	52.27
138	18.42	5.86	7.65	3.60	13.18
139	29.85	9.50	22.87	10.75	39.41
140	52.39	16.68	98.15	46.13	169.12
141	60.96	19.41	143.61	67.50	247.47
142	29.21	9.30	21.68	10.19	37.36
143	48.26	15.37	79.57	37.40	137.10
144	36.83	11.73	39.34	18.49	67.78
145	34.61	11.02	33.43	15.71	57.60
146	58.74	18.71	130.93	61.54	225.62
147	43.18	13.75	59.65	28.04	102.78
148	43.82	13.95	61.96	29.12	106.77
149	52.07	16.58	96.64	45.42	166.53
150	46.99	14.96	74.28	34.91	128.00
151	41.28	13.14	53.02	24.92	91.36
152	25.40	8.09	15.60	7.33	26.89
153	41.59	13.25	54.09	25.42	93.21
154	34.29	10.92	32.64	15.34	56.24
155	25.40	8.09	15.60	7.33	26.89
156	75.57	24.07	242.45	113.95	417.77
157	46.67	14.86	72.99	34.31	125.77
158	43.50	13.85	60.80	28.58	104.76
159	39.05	12.44	45.87	21.56	79.03
160	41.28	13.14	53.02	24.92	91.36
161	76.84	24.47	252.31	118.59	434.77
162	42.55	13.55	57.39	26.97	98.89
163	18.42	5.86	7.65	3.60	13.18
164	52.39	16.68	98.15	46.13	169.12
165	44.45	14.16	64.32	30.23	110.84
166	58.10	18.50	127.43	59.89	219.57
167	75.57	24.07	242.45	113.95	417.77
168	24.13	7.68	13.98	6.57	24.10
169	65.09	20.73	168.81	79.34	290.89
170	60.96	19.41	143.61	67.50	247.47
171	74.61	23.76	235.18	110.53	405.25

Tree No.	CBH* (cm)	DBH* (cm)	Total Biomass (kg)	Carbon Stock (kg)	Sequestered CO_2 (kg)
172	29.21	9.30	21.68	10.19	37.36
173	65.72	20.93	172.88	81.25	297.90
174	62.23	19.82	151.14	71.03	260.43
175	28.58	9.10	20.54	9.65	35.40
176	46.36	14.76	71.71	33.71	123.57
177	66.36	21.13	177.00	83.19	305.00
178	76.84	24.47	252.31	118.59	434.77
179	46.99	14.96	74.28	34.91	128.00
180	49.21	15.67	83.66	39.32	144.16
181	33.02	10.52	29.59	13.91	50.99
182	45.09	14.36	66.74	31.37	115.00
183	56.83	18.10	120.56	56.66	207.75
184	32.39	10.31	28.15	13.23	48.50
185	52.71	16.79	99.67	46.84	171.74
186	60.96	19.41	143.61	67.50	247.47
187	39.37	12.54	46.85	22.02	80.73
188	24.13	7.68	13.98	6.57	24.10
189	60.96	19.41	143.61	67.50	247.47
190	16.83	5.36	6.67	3.14	11.50
191	61.28	19.52	145.48	68.37	250.67
192	45.72	14.56	69.20	32.52	119.24
193	36.20	11.53	37.58	17.66	64.76
194	29.85	9.50	22.87	10.75	39.41
195	32.39	10.31	28.15	13.23	48.50
196	69.85	22.25	200.56	94.27	345.60
197	16.51	5.26	6.48	3.05	11.17
198	73.66	23.46	228.03	107.17	392.92
199	17.78	5.66	8.95	4.20	15.42
200	42.23	13.45	56.28	26.45	96.97
201	22.86	7.28	12.57	5.91	21.66
202	35.56	11.32	35.88	16.87	61.83
203	58.42	18.61	129.17	60.71	222.59
204	20.96	6.67	10.83	5.09	18.66
205	22.23	7.08	11.94	5.61	20.57
206	34.93	11.12	34.23	16.09	58.99
207	53.72	17.11	104.61	49.17	180.26
208	20.32	6.47	8.82	4.15	15.20
209	44.45	14.16	64.32	30.23	110.84
210	33.02	10.52	29.59	13.91	50.99
			18400.24	**8648.14**	**31706.27**

**CBH = Circumference at Breast Height, DBH = Diameter at Breast Height*

4. CONCLUSION

This study provides an in-depth review of biomass production, carbon stock, and sequestered CO_2 in an 18-year-old teak plantation, revealing significant diversity across individual trees. Regression models with high R^2 values (0.9993) show a substantial association between parameters and diameter at breast height (DBH). This validates DBH as a reliable predictor of tree biomass, carbon stock, and sequestered CO_2. These results demonstrate the significant potential of teak plantations in contributing to carbon sequestration efforts and support the inclusion of teak plantations in carbon offset and climate mitigation strategies. Engaging local communities in plantation and conservation efforts, raising awareness about the environmental benefits of teak plantations can encourage community participation and support for sustainable forestry practices. Future research and management strategies can build on the results of this study, helping safeguard the long-term viability of teak plantations and their role in climate change mitigation through effective carbon sequestration.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Authors hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

ETHICAL APPROVAL

This study was approved by the Institutional Ethical Committee (IEC) of Government Nagarjuna Post Graduate College of Science, Raipur, Chhattisgarh, under approval number 21/2024. All procedures performed in this study involving human participants were in accordance with the ethical standards of the IEC.

DATA AVAILABILITY

The data generated and/or analyzed during the present study are available from the corresponding author upon reasonable request.

ACKNOWLEDGEMENT

Authors are thankful to the administration of Pt. Ravishankar Shukla University, Raipur for permission to do this work in the campus. We are also thankful to Mr. Neeraj Patel, M.Sc. (Botany) student of Guru Ghasidas Vishwavidyalaya (A Central University), Bilaspur for his help during data collection.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Forest Survey of India. India State of Forest Report 2019. Ministry of Environment, Forest and Climate Change, Government of India; 2019.
2. Sreejeesh KK, Thomas TP. Carbon Sequestration Potential of Teak Plantations of Kerala (Doctoral dissertation, Cochin University of Science and Technology); 2016.
3. Subba S, Honnurappa S. Exploring carbon sequestration potential across various clones in teak plantation. International Journal of Economic Plants. 2024;11(Feb,1):056-059.
4. Chaturved OP, Kaushal R, Alam NM. Biomass production and carbon stock of Teak (*Tectona grandis* Linn. f.) plantations in central India. Indian Forester. 2011;137(12):1402-1408.
5. Basu S, Das AK, Rakshit N. Carbon sequestration potential of different aged teak (*Tectona grandis* L.f.) plantations in tropical moist deciduous forest of north Bengal, India. Journal of Forest and Environmental Science. 2018;34(3):181-190.
6. Buba T. Relationships between stem diameter at breast height (DBH), tree height, crown length, and crown ratio of Vitellaria paradoxa CF Gaertn in the Nigerian Guinea Savanna. African Journal of Biotechnology. 2013;12(22): 3441-3446.
7. Sharma A, Naik ML. Biomass and productivity studies in teak (*Tectona grandis* L.f.) under artificial plantation in Surguja District (M.P.). Journal of Tropical Forestry. 1989;5(3):97-104.
8. Hairiah K, Sitompul SM, Van Noordwijk M. Methods for sampling carbon stocks above and below ground (pp. 1-23). Bogor, Indonesia: ICRAF; 2001.
9. Chave J, Andalo C, Brown S, Cairns MA, Chambers JQ. Tree allometry and improved estimation of carbon stocks and balance in tropical forests. Oecologia. 2005;145(1):87-99.
10. Chaturvedi RK, Raghubanshi AS. Assessment of carbon density and accumulation in mono-and multi-specific stands in Teak and Sal forests of a tropical dry region in India. Forest Ecology and Management. 2015;339:11-21.
11. Suresh HS, Dattaraja HS, Sukumar R. Relationship between annual rings and monsoon rainfall in a teak plantation in the dry tropics of India. Tree-Ring Research. 2010;66(2):105-117.
12. Karmacharya SB, Singh KP. Biomass and net primary productivity of teak plantations in dry tropical regions of India. Forest Ecology and Management. 1992;55(1-4):233-247.
13. Nowak DJ, Crane DE. Carbon storage and sequestration by urban trees in the USA.

Environmental Pollution. 2002; 116(3):381-389.
14. Kishwan J, Pandey R, Dadhwal VK. India's forest and tree cover: Contribution as a carbon sink. Technical Paper, Indian Council of Forestry Research and Education, Dehradun, India; 2009.

Peer-review history:
The peer review history for this paper can be accessed here:
https://prh.ikprress.org/review-history/12478