

Original Article

Assessing the Impact of Teak Plantations on Soil Properties in Vidarbha, Maharashtra: A Comparative Study of Soil Composition between Teak Plantations and Adjacent Non-Plantation Areas

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Abstract

This study explores the relationship between student engagement and perceived social support among secondary school students. The research aimed to examine how different sources of social support—namely, from family, peers, and teachers—correlate with cognitive, emotional, and behavioural engagement in school settings. A quantitative correlational research design was used, using survey data collected from 400 secondary school students across various CBSE and PSEB Schools. Standardized instruments were used to measure levels of perceived social support and student engagement. Statistical analyses, including Pearson correlation and two-way analysis of variance were conducted to identify significant relationships between variables. Findings revealed a positive and significant correlation between perceived social support and student engagement. The female students are more engaged and perceived higher social support as compared to male pupils. Additionally, the current study found that pupils in various age groups vary significantly with respect to cognitive as well as the affective aspect of student involvement. According to the current research, there are no differences in social support amongst pupils of different ages. These results highlight the importance of nurturing supportive relationships within the school environment to enhance student engagement. The study concludes by recommending that educational stakeholders develop strategies to strengthen social support systems within schools to promote more engaged, motivated, and successful students.

Keywords: Student Engagement, Perceived Social Support, Secondary School Students, Cognitive Engagement, Behavioural Engagement, Emotional Engagement, Gender Differences

Introduction

India's megadiverse status, encompassing 8% of global biodiversity, is reflected in its vast area of 328.73 million ha, making it the seventh largest country. About one-fifth of India's geographical area is covered with forests, and approximately 45,000 plant species exist in India. The commercially important tree *Tectona grandis* (Teak) is classified within the Lamiaceae family and is a major species used in tree plantations, which is naturally distributed in India. (K.Palanisami et al. (2009). In Vidarbha, the percentage of cultivated land is around 54.4% of the total geographical area, while the land under forest is about 21.8%, and barren and unculturable land is approximately 12.3%. (State Forest Report). Natural teak forests are predominantly found in the Vidarbha region of Maharashtra, specifically in the districts of Nagpur, Bhandara, Gondiya, Yavatmal, and Chandrapur. The soil and site conditions significantly influence the quality, growth, and distribution of teak in these areas. Teak growth is significantly impacted by soil conditions, particularly soil moisture, as it is vulnerable to poor drainage. Soil texture, pH, and nutrient levels (nitrogen, phosphorus, and potassium) are key factors influencing teak's growth and development.

In this study, about 146474 ha. area under teak plantations is studied. This research focuses on a large teak plantation area in Vidarbha, India, encompassing five districts and 27 towns. The study examines the impact of teak plantations on soil properties by comparing soil samples from plantation areas and adjacent, non-plantation areas.

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Study area

The study area is divided into five districts of Vidarbha and covers nearly 29 towns, namely Nagpur (rural), Umred, Kuhi, Paoni, Hiwara, Risala, of Nagpur district, Chandrapur, Pitezari, Lakhni, of Bhandara district, Salekasa, Jamdi, Dongargaon, Chichgad, Deori, Arjuni Morgaon, of Gondia district, Yawatmal (rural), Ladheda, Pusad, Wani, Mohada, Ghatanji, of Yawatmal district, Junona, Mamla, Chichpalli, Khadsangi, Zaran, Kanhargao, Tohogaon, Dabha of Chandrapur district. Site maps were created by taking longitude and latitude coordinates with a handheld Global Positioning System (GPS). Soil samples were collected from each site for the areas that are under teak and the adjacent areas that are not under the teak plantation. To compare the effect of teak plantation on important soil parameters.

Materials and Methods

To ensure the objective of the present study, a detailed literature survey has been completed to address these challenges, and the implementation of established protocols is vital for achieving reliable and consistent results, free from any personal bias. Based on the literature survey a standard method of studying different soil parameters is developed. The study area consists of a significant teak plantation, is about ...ha. of five districts within the Vidarbha region which are Nagpur, Bhandara, Gondia, Yawatmal, and Chandrapur includes a total of 27 towns across these districts. Soil samples were collected from two types of locations: areas under teak plantations and nearby areas without teak plantations. The primary goal is to assess how teak plantations affect key soil characteristics by comparing the soil properties of the two sample sets.

Sample collection**Laying of sample plots**

The areas that are representative of that division are identified, and the boundaries of plantations are vindicated. When there is a large plantation then it is divided into different sections. There is a substantial difference between the rate of growth of *Tectona grandis* spp. at different sites selected in this study, so the area is studied from stock maps of that particular plantation. 20 X 20 meters representative sample plots are laid. (Maharashtra Forest Records No.III, Silviculture Manual.) While selecting the sample plot following standards are followed:

Location: Placing sample plots on the borders of the representative area is avoided.

Representation: sample plots are selected strategically to encompass various terrain and crop conditions.

Shape: It was ensured that the Sample plots must be rectangular.

Marking: To indicate the plot boundaries, trees are marked.

Size: It was ensured that each plot should cover 3-5% of the total area within its quality class.

Soil sample collection

Soil samples were collected at a depth of 15-30 cm, each weighing approximately 300 grams, during the dry months of April and May to ensure consistent results using the quadrat sampling method. Areas like wet spots and irrigation channels were avoided. Clean, non-contaminated tools were used, and ten samples were collected per location. Samples were immediately sealed in labelled plastic bags and air-dried on a clean surface. After drying, they were gently crushed using a wooden rolling pin, sieved through a 2mm mesh to remove debris, and then analysed for pH, Electrical Conductivity (EC) using pH and Conductivity Meters, Organic Carbon (OC) using the Walkley-Black method, and NPK using a soil test kit.

Results and Discussions

Teak forest distribution, extent, and growth are significantly influenced by soil drainage and its impact on soil conditions. Specifically, teak growth is directly correlated with factors like soil pH, Elemental Carbon content, and the ratio of Nitrogen, Phosphorus, and Potassium (NPK). However, the influence of organic carbon on teak growth is minimal.

The total forest cover under the selected five divisions is Nagpur, Bhandara, Gondia, Yawatmal, and Chandrapur, depicted in Figure 1. In Maharashtra, moist teak forest cover is 10.71% and dry teak forest cover is 17.40 % which means out total teak forest cover is 28.11 %, and out of these, the major *Tectona grandis* forests are found in the districts mentioned above.

Different plantation sites are selected from the above five divisions, and the physical and chemical characteristics of soils under *Tectona grandis* spp. and the soils of the adjacent area, that is, non-teak areas, are observed and calculated. Representative Sample plots are laid, and 100% enumeration of every sample plot is done.

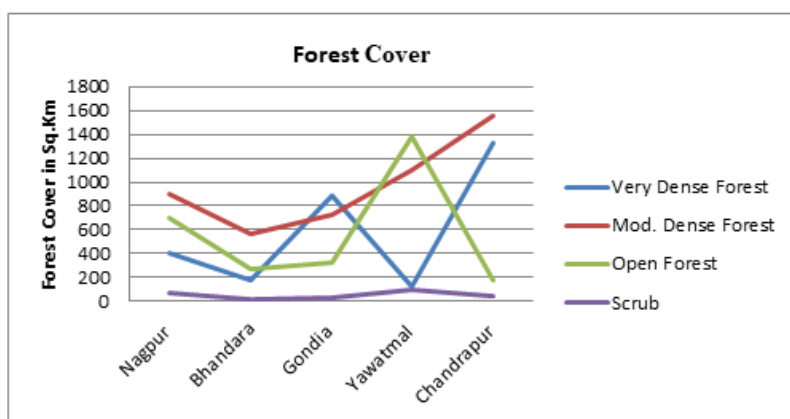


Figure 1. Forest cover of the selected region for this study

The average values of physicochemical parameters of soils under teak plantation and non-teak plantations are depicted in Table 1.

Colour and Texture

The colour and texture of soil samples were visually assessed and varied between reddish brown to dark brown in teak plantations and light brown to gray in non-teak areas. Teak plantation soils were sandy loam, while non-teak areas had clay loam soils.

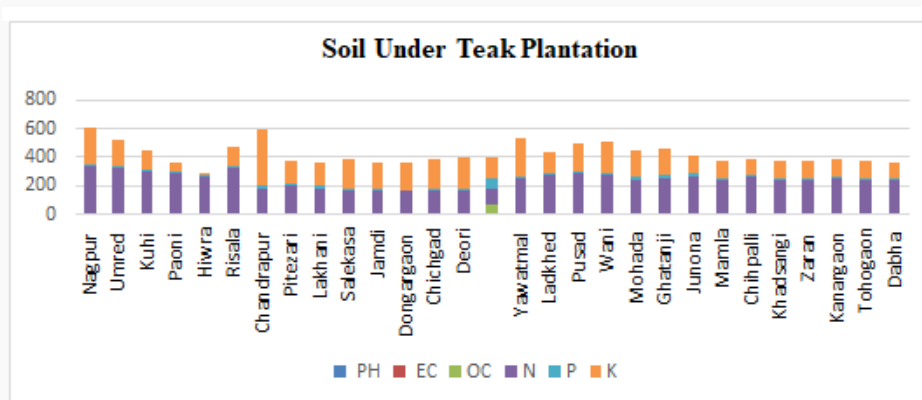


Figure 2. Levels of physicochemical parameters in the soil under the teak plantation

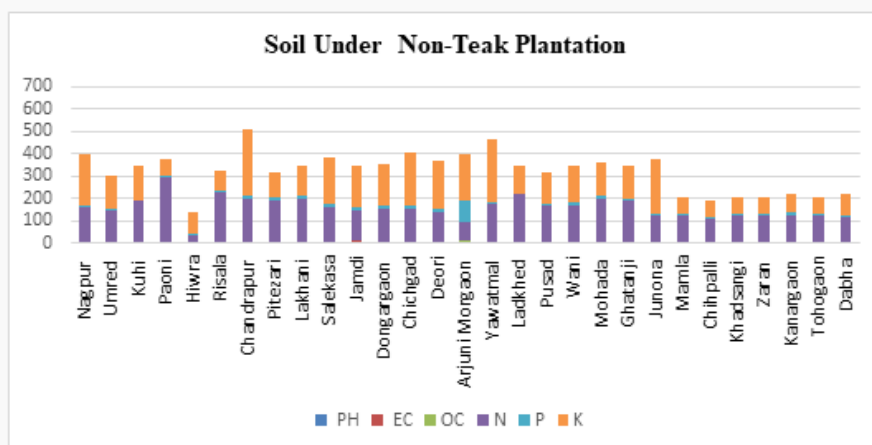


Figure 3. Levels of physicochemical parameters in the soil under the non-teak plantation



S. N	Name of the area surveyed	Area in ha.	Location	Colour of Soil under the teak plantation	Colour of Soil under non-teak plantation	Texture of Soil under the teak plantation	Texture of Soil under non-teak plantation	Teak						Non-Teak					
								PH	EC	OC	N	P	K	PH	EC	OC	N	P	K
1	Nagpur	22131	20.35 N 79.40 E	Redish Brown	Gray	Sandy Loam	Clay Loam	6.7	0.59	0.92	330.68	14.51	249.68	6.87	0.58	0.45	152.25	11.78	231.06
2	Umred	8847.5	20.51N 17.19 E	Dark Brown	Light Brown	Sandy Loam	Clay Loam	6.7	0.61	0.30	322.60	14.30	174.65	7.06	0.62	0.29	140.80	4.96	147.78
3	Kuhi	3362.8	21.07 N, 79.07E	Dark Brown	Gray	Sandy Loam	Clay Loam	6.8	0.76	0.30	292.60	13.60	128.41	6.97	0.65	0.22	181.67	1.24	154.78
4	Paoni	3855.1	21.52 N, 79.35 E	Dark Brown	Light Brown	Sandy Loam	Clay Loam	6.7	1.09	0.30	277.00	12.36	67.08	6.94	0.80	0.16	293.67	3.05	79.28
5	Hiwra	3518.3	21.36 N 79.28 E	Dark Brown	Gray	Sandy Loam	Clay Loam	6.8	1.30	0.60	259.00	10.96	3.30	6.70	0.93	0.07	31.70	5.30	95.00
6	Risala	2547.5	21.47N, 79.007 E	Dark Brown	Light Brown	Sandy Loam	Clay Loam	6.6	0.86	0.50	314.40	13.69	137.45	6.86	0.71	0.26	221.20	5.94	93.66
7	Chandrapur	2863.2	21.196N, 79.812 E	Dark Brown	Gray	Sandy Loam	Clay Loam	7.2	0.29	1.51	175.43	18.24	395.91	7.27	0.31	1.63	193.86	15.45	293.72
8	Pitezari	3418	21.197 N, 80.012 E	Redish Brown	Light Brown	Sandy Loam	Clay Loam	7.2	0.28	1.70	190.66	17.36	163.58	7.26	0.29	0.20	188.67	14.14	110.00
9	Lakhani	4819.6	21.0699 N, 79.829 E	Dark Brown	Gray	Sandy Loam	Clay Loam	7.2	0.37	1.11	177.91	15.77	163.38	7.17	0.24	0.13	192.68	15.25	131.92
10	Salekasa	5736.1	21.303N ,80.490 E	Dark Brown	Light Brown	Sandy Loam	Clay Loam	7.1	0.25	1.53	156.17	14.54	208.74	7.11	0.26	0.60	155.32	13.97	206.65
11	Jamdi	8632.4	20.860N, 80.427 E	Dark Brown	Gray	Sandy Loam	Clay Loam	7.1	0.21	0.99	157.59	10.29	192.75	6.96	2.80	1.55	133.46	14.52	189.97
12	Dongargaon	1349.2	20.794N, 80.256 E	Orange, Brown	Light Brown	Sandy Loam	Clay Loam	7.2	0.32	1.06	155.91	10.22	185.09	7.05	1.50	0.29	146.19	14.10	187.64

13	Chichgad	5960.6	20.893N, 80.353 E	Orange, Brown	Gray	Sandy Loam	Clay Loam	7.2	0.32	1.61	159.17	14.85	208.74	7.09	0.26	0.64	148.62	14.60	236.73
14	Deori	4361.5	21.075N, 80.353 E	Orange, Brown	Gray	Sandy Loam	Clay Loam	7.2	0.25	1.16	157.95	10.64	222.63	7.04	0.26	0.37	131.53	14.71	217.03
15	Arjuni Morgaon	4832	20.812N, 80.031 E	Orange, Brown	Gray	Sandy Loam	Clay Loam	7.2	1.01	65.29	102.96	82.59	135.52	4.33	0.57	69.19	85.41	90.89	212.63
16	Yawatmal	4162.8	20.390N, 78.128 E	Dark Brown	Gray	Sandy Loam	Clay Loam	7	0.42	0.83	240.88	13.65	267.18	7.03	0.42	0.42	169.23	11.88	279.13
17	Ladkhed	5961	20.345N, 77.914 E	Dark Brown	Gray	Sandy Loam	Clay Loam	6.8	0.77	0.59	273.64	13.11	144.40	7.01	0.63	0.22	210.53	6.44	122.00
18	Pusad	2907.3	19.910N, 77.569 E	Dark Brown	Gray	Sandy Loam	Clay Loam	6.9	0.53	0.96	281.80	14.58	186.83	7.09	0.50	0.24	161.10	10.39	142.06
19	Wani	4305.2	20.056N, 78.951 E	Dark Brown	Gray	Sandy Loam	Clay Loam	6.9	0.50	0.81	272.72	12.59	211.30	6.99	0.50	0.29	165.10	10.39	164.59
20	Mohada	6719.1	20.223N, 78.465 E	Dark Brown	Gray	Sandy Loam	Clay Loam	7.1	0.42	1.13	235.78	15.95	189.33	7.07	0.44	1.45	193.67	11.80	147.76
21	Ghatanji	3315.2	20.143N, 78.311 E	Redish Brown	Light Brown	Sandy Loam	Clay Loam	7.1	0.48	1.18	247.64	16.72	184.90	7.12	0.43	1.45	182.00	11.44	144.75
22	Junona	8309.3	19.929N, 79.393 E	Redish Brown	Light Brown	Sandy Loam	Clay Loam	7.2	0.83	0.69	262.15	14.89	124.07	7.10	0.62	0.42	118.07	8.62	242.31
23	Mamla	4499.5	20.030N, 79.388 E	Redish Brown	Light Brown	Sandy Loam	Clay Loam	7.2	0.69	0.91	233.49	14.49	114.52	7.16	0.54	0.16	117.90	8.69	75.42
24	Chihpalli	7202.7	20.001N, 79.474 E	Redish Brown	Light Brown	Sandy Loam	Clay Loam	7.2	0.73	0.74	253.37	13.83	109.52	7.09	0.57	0.16	104.40	7.73	74.52
25	Khadsangi	3885.4	20.506N, 79.266 E	Redish Brown	Light Brown	Sandy Loam	Clay Loam	7.2	0.69	0.91	233.49	14.49	114.52	7.16	0.54	0.16	117.90	8.69	75.42
26	Zaran	8726.6	19.986N, 79.366 E	Redish Brown	Light Brown	Sandy Loam	Clay Loam	6.8	0.69	0.91	233.49	14.49	114.52	7.16	0.54	0.16	117.90	8.69	75.42
27	Kanargaon	9691.8	19.738N, 79.543E	Redish Brown	Light Brown	Sandy Loam	Clay Loam	7	0.70	1.01	244.91	16.58	114.85	7.17	0.55	0.16	120.27	9.79	81.55
28	Tohogaon	6589.1	19.667N, 79.508 E	Redish Brown	Light Brown	Sandy Loam	Clay Loam	7.2	0.69	0.91	233.49	14.49	114.52	7.16	0.54	0.16	117.90	8.69	75.42
29	Dabha	6094.7	19.624N, 79.649 E	Redish Brown	Light Brown	Sandy Loam	Clay Loam	7.2	0.69	0.79	227.26	13.40	117.40	7.14	0.53	0.18	110.27	8.05	94.15

Table1. Physicochemical characteristics of soils of the study area.

Potential of Hydrogen(pH):

The pH of soils suitable for teak plantation typically falls between 6.7 and 7.5, with a slightly acidic to neutral range of 6.6 to 7.9 being optimal in all the 29 areas surveyed. While variations in pH can occur due to edaphic factors, teak plantations in five districts consistently show pH levels within this optimal range. Conversely, non-teak soils in the adjacent areas of these districts generally have a pH below 6.0, which is considered unsuitable for teak growth.

Electrical Conductivity (EC):

Electrical conductivity (EC) in the soil, indicating the presence of dissolved salts and nutrients, ranged from a low to a high value. While a moderate EC is generally beneficial for teak plant growth, extremely high or low levels can be detrimental. The average EC in teak plantation soil was found to be different from that in non-teak soil in overall area. Although EC varied with soil depth, the distribution of soluble salts did not significantly differ between the teak and non-teak soils.

Organic Carbon (OC):

Teak plantations, due to their specific characteristics, tend to have higher levels of organic carbon in the soil. This is particularly true at the surface, where leaf litter and other organic debris from the trees fall and decompose. High levels of organic matter, and specifically organic carbon, are essential for healthy teak growth due to their positive impact on soil structure, water retention, and nutrient availability. Teak plantations typically exhibit higher organic carbon content, particularly at the surface where litterfall accumulates, compared to non-teak areas. The increase in soil organic carbon, influenced by litterfall and its subsequent decomposition, is directly linked to greater biomass production in teak plantations.

Nitrogen, Phosphorus, and Potassium (NPK):

While a balanced NPK (Nitrogen, Phosphorus, Potassium) ratio is generally beneficial, teak thrives with elevated levels of calcium, phosphorus, and potassium. Nitrogen, while essential for leaf development and photosynthesis, isn't the sole driver of teak's growth. The specific NPK ratio and overall nutrient balance in teak plantation soils are often more favourable, and a balanced NPK ratio is observed in the soils under teak plantation compared to non-teak areas, supporting the tree's specific needs. In essence, teak thrives in deep, well-drained alluvial soils rich in organic matter, calcium, and other essential nutrients, with a pH near neutral.

Conclusion:

Teak plantations demonstrably improve soil health through several mechanisms. Increased soil organic carbon, enhanced water retention and drainage, and improved nutrient cycling are all positive outcomes. Furthermore, teak plantations can stabilize soil pH, foster a healthy soil structure, and mitigate erosion. They also play a role in land restoration and biodiversity enhancement, while simultaneously providing economic benefits.

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Conflicts of interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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