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# CHLOROPHYLL CONTENT STUDIES FROM INCEPTION OF LEAF BUDS TO LEAF-FALL STAGES OF TEAK (*TECTONA GRANDIS*) OF KAPILASH FOREST DIVISION, DHENKANAL, ODISHA

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**Abstract**

Attempts have been made to study the changes in chlorophyll contents of Teak leaves from the inception of the leaf buds to leaf fall. During early April the leaf buds appears. Growth and developement occurs upto September. From Sept. Onwards the process of senescence starts. The leaf fall occurs in next January. The chlorophyll contents increase from April to September having the inception of leaf buds to complete maturity of the leaves.The increase in chlorophyll contents of leaf at upper stratum found from 0.85 $mg.g^{-1}$(in April 09) to 3.43 $mg.g^{-1}$ (in Sept.09) wherease the same at the lower stratum 0.97$mg.g^{-1}$ (in April 09) to 3.89 $mg.g^{-1}$ (inSept.09). These after the chlorophyll contents decreases upto next January as the complete leaf fall starts. It was observed that The chlorophyll contents starts decreasing from 3.43 $mg.g^{-1}$ (in Sept.09) to 1.14$mg.g^{-1}$ (in Jan.10) at the upper stratum from 3.89 to 1.44 $mg.g^{-1}$ at the lower stratum from Sept. to January.

**Key words:** chlorophyll, Tectona grandis, stratum,variation, inception, budding, senescence.

## INTRODUCTION

The quantity of photosynthetic pigments in leaf biomass has been widely used as index of vitality of the photosynthetic machinery and consequently of primery productive potential of an ecosystem [1,2,3,4]. The combustion of fuel in engines of motor gives rise to sulphur dioxide (SO2), nitrogen oxides (NOx) and $CO_2$, as well as suspended particulate matter. These pollutants when absorbed by the leaves cause a reduction in the concentration of photosynthetic pigments viz., chlorophyll and carotenoids, which directly affect to the plant productivity. Chlorophyll is the principal photoreceptor in photosynthesis, the light-driven process in which carbon dioxide is “fixed” to yield carbohydrates and oxygen [5].There is a rapid change in the quantity of photosynthetic pigments in forest communities during the course of a year as vast amount of pigments are produced with the inception of leaf buds, their expansion and maturity, and then decline during senescence and leaf fall stage. The cycle is repeated year after year. This cycle of chlorophyll contents is responsible for bringing about growth and the supply of metabolic energy to the members of a community. The change in the colour of leaves of deciduous trees from brighter green in mature to pale green in old leaves is primarily due to the preferential destruction of the chlorophyll . Quantitative changes in the chlorophyll have been investigated in the present case during the life span of teak leaves. There are many works on pigment contents but information on variations in the pigment concentration from leaf fall stage is not available for the tropical conditions. Therefore through this investigation the pigment dynamics in relation to the age of leaves in deciduous teak plant has been worked out [6]. Chlorophyll measurement is an important tool to evaluate the effects of air pollutants on plants as it plays an important role in plant metabolism and any reduction in chlorophyll content corresponds directly to plant growth [7]. Leaf chlorophyll content and carotenoids thus can provide valuable information about physiological status of plants.

## MATERIAL AND METHODS

The study was carried out in a deciduous forest of 18-year old teak plantation in Kapilash Forest land($20^0$ $35^{'}$ – $21^0$ $10^{'}$ latitudes and $85^0$ $05^{'}$ – $86^0$ $10^{'}$ longitudes) of Dhenkanal forest division. The climate is worm and humid characterised by five seasons i.e,

(i) Hot & dry Summer(April,May &June).....3 months
(ii) Hot humid Wet season (July,August & September).....3 months
(iii) The Autumn(October & November).....2 months
(iv) The Winter(December & january).....2 months
(v) The Spring(February & March).....2 months

The total rainfall for the year April 2009 to January 2010 was 2000mm. Leaf samplings were done from two strata i.e, upper and lower, of a few labelled teak plants at regular monthly intervals starting from April 2009 when leaves come out in form of buds up to January 2010 when leaf fall is completed. Harvested leaves were kept in ice-box and taken to the laboratory for extraction of the pigments. 12-15 leaves were choosen at random for extraction of pigments and a similar number for oven drying to determine the dry weight of the leaf. The leaf samples were analysed for chlorophyll a,chlorophyll b as total chlorophyll content. Leaves were ground in a mortar under acetone(80%) with acid washed sand, the mass was filtered through a sintered glass filter. The acetone extracts were transferred in a separating funnel and combined with an equal volume of a non polar solvent, i.e, petrolium ether, followed by water added drope wise until two layers were formed. The upper non polar layer contained chlorophylls and the lower one held the water soluble pigments. The lower layer was run off and the remaining upper layer was washed free from acetone with distilled water repeatedly. The extract was made up to a known volume and cleared by repeated centrifugation at 2000-3000 r.p.m. chlorophylls a, b were determined colorimetrically by measuring absorbance at wavelength of 663 nm for total chlorophyll (a+b) and at 480 nm. The values of chlorophylls were estimating by the following formula [9,10].

Total chlorophyll ($mg.l^{-1}$) = $20.2\ D_{645} + 8.02\ D_{663}$
Clorophyll a ($mg.l^{-1}$) = $12.7\ D_{663} - 2.69\ D_{645}$
Chlorophyll b($mg.l^{-1}$) = $22.9\ D_{645} - 4.68\ D_{663}$
Later values were converted to $mg.l^{-1}$ dry weight for leaves.
All the datas are evaluated by using the MS Excel and SPSS v 20.

## RESULTS AND DISCUSSION

Monthly variation in the average values of chlorophyll a, chlorophyll b and the total chlorophyll of teak leaves from leaf initiation to leaf fall stages have been presented in the table. It can be seen from the given table that in the beginning, before the leaf buds are completely open i.e, in April, chlorophyll content is low(0.85 $mg.g^{-1}$ in upper stratum and 0.97$mg.g^{-1}$ in lower stratum) but there is a sharp increase at the onset of rainy season when the buds have unfolded, and then the level remained high throughout the rainy season attaining the peak values of 3.89 $mg.g^{-1}$ and 2.82 $mg.g^{-1}$ for upper and lower strata leaves in September. At the advent of winter season total chlorophyll concentration decreased significantly in both upper and lower strata and this decreasing trend continued till the desiccation of intact leaf just before its fall on ground.

Both chlorophyll a and b contents followed the same trend of rise as the total chlorophyll contents in post maturity stages there was also a change in the amount of the chlorophyll a & chlorophyll b. From peak values at maturation stage (September) with chlorophyll a contents of 2.42 $mg.g^{-1}$ and 2.67 $mg.g^{-1}$ in upper and lower strata leaves their amounts decreased to 0.52 $mg.g^{-1}$ (upper stratum) and 0.7 $mg.g^{-1}$ (lower stratum) by the time leaf falls (January). So from the study it comes to know that chlorophyll a is more readily destroyed than chlorophyll b in teak leaves. [11,12,13,14,15] have also indicated preferential destruction of chlorophyll a as a general phenomenon and has emphasized that the process begins while the leaves are still on thhe growing plant in the field. At the stage when the leaf fall starts i.e, in January, because from February to March the complete leaf fall occurs and in April it starts reappearance on iniciation of leaves starts chlorophyll b concentration exceeded to chlorophyll a in both strata due to slower rate of disappearance of chlorophyll b.the variation of chlorophyll content in both the stratum is shown in graphical manner that the figure 1 and 2 shows the variations of chlorophyll content of chlorophyll a and b respectively. Mean variation of total chlorophyll content of upper stratum is 1.9920 ± 0.75284 with standard error (SE) of 0.23807 & that of lower stratum is 2.3420 ±0.87245 with SE of 0.27589 & the difference between the two

is significant (i.e., p=0.001). Month wise variation of chlorophyll content in upper stratum exhibiting a cubic curve which is explainable 80.9% & in lower stratum exhibiting a cubic curve which is explainable 84.5% and the difference between the two is significant (F= 18.176 ,p=0.05). There is also significant difference in variation of chlorophyll content among three stages (budding stage,mature stage,litter fall stage)is also significant(F=109.942,p=0.009).

Ratio of chlorophyll a to chlorophyll b was relatively low in buds, it increased rapidly to a high level at the advent of rainy season and it attained maximum value (1 and 1.21 for upper and lower strata, respectively) in the month of September when leaves were fully grown. It can be seen from the given table that the levelof chlorophyll a : b ratio remained high through out the rainy season after which it dropped significantly in the winter season starting from January. The chlorophyll a : b ratio remained high in upper canopy than in lower throughout the whole period sampling [16] . This can be attributed to the fact that shade leaves (lower stratum) are rich in chlorophyll b in ratio to chlorophyll a than leaves exposed to better sunlight (upper stratum). At the rapid declination of chlorophyll a, it is assumed that small fraction of chlorophyll a gets converted to pheophytin a which is stable enough to be present for long periods in dry leaves [17] as in the graph 1and 2 where the month wise variation of chlorophyll a and b is shown respectively. The leaf exposed to full sunlight may differ in growth from those growing inshade; adaptation can be associated with morphological, physiological and ultrastructural changes in leaves [17,18] suggested that leaf structure undergoes through ontogenic progression, which are at the same time sensitive to environmental changes, leading to large changes in specific leaf area (SLA). According to conversion of chlorophyll a to pheophytin a is more rapid than chlorophyll b to pheophytin b, thus explaining the faster disappearance of chlorophyll a and chlorophyll b may also be due to conversion of former into latter as evidences as there to favour the view that chlorophyll b is synthesized from chlorophyll a [19,20,21].

**Table : 1**

| **Months** | **Stratum** | **Total clorophyll(mg. $g^{-1}$)** | **Chlorophyll a ($mg.g^{-1}$)** | **Chlorophyll b ($mg.g^{-1}$)** | **Chlorophyll a/b ratio** |
|---|---|---|---|---|---|
| **April-2009** | Upper | 0.85 | 0.45 | 0.4 | 1.12 |
| | Lower | 0.97 | 0.5 | 0.47 | 1.06 |
| **May** | Upper | 1.67 | 0.94 | 0.75 | 1.25 |
| | Lower | 1.95 | 1.04 | 0.94 | 1.10 |
| **June** | Upper | 2.04 | 1.17 | 0.89 | 1.31 |
| | Lower | 2.17 | 1.23 | 0.96 | 1.28 |
| **July** | Upper | 2.16 | 1.27 | 0.91 | 1.3 9 |
| | Lower | 2.2 | 1.64 | 1.21 | 1.35 |
| **August** | Upper | 2.23 | 1.43 | 0.82 | 1.74 |
| | Lower | 2.95 | 1.84 | 1.13 | 1.62 |
| **Sept** | Upper | 3.43 | 2.42 | 1 | 2.42 |
| | Lower | 3.89 | 2.67 | 1.21 | 2.20 |
| **Oct** | Upper | 2.82 | 1.94 | 0.9 | 2.1 |
| | Lower | 3.36 | 2.23 | 1.15 | 1.93 |
| **Nov** | Upper | 1.94 | 1.26 | 0.66 | 1.90 |
| | Lower | 2.5 | 1.61 | 0.87 | 1.85 |
| **Dec** | Upper | 1.64 | 0.95 | 0.71 | 1.33 |
| | Lower | 1.99 | 1.14 | 0.87 | 1.31 |
| **Jan-2010** | Upper | 1.14 | 0.64 | 0.52 | 1.23 |
| | Lower | 1.44 | 0.76 | 0.7 | 1.08 |

**Figure-2**

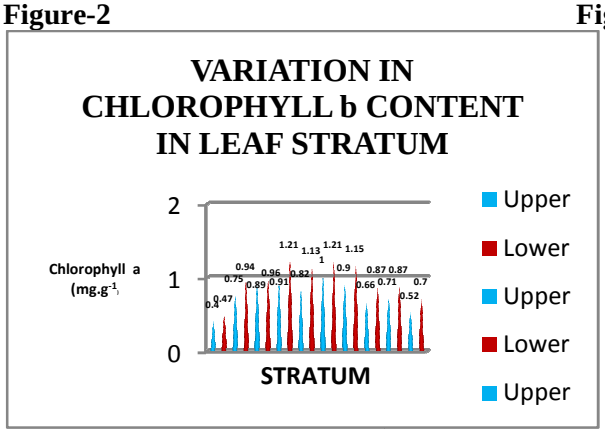
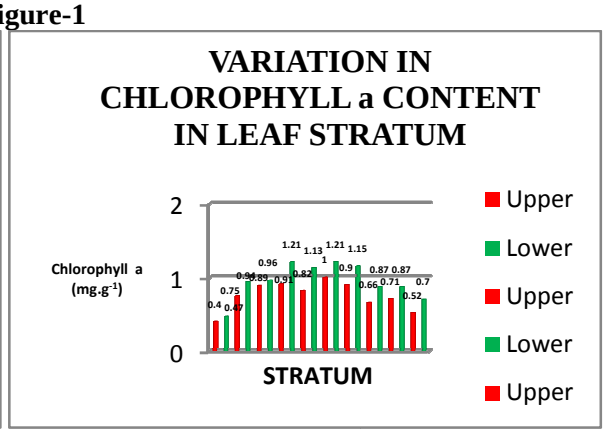
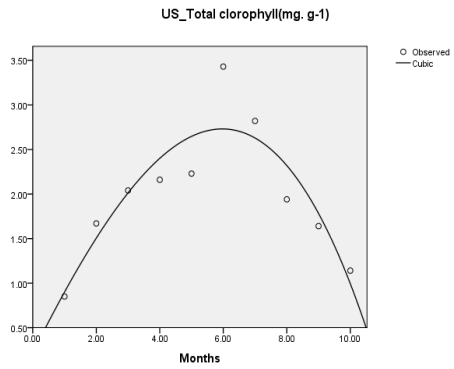


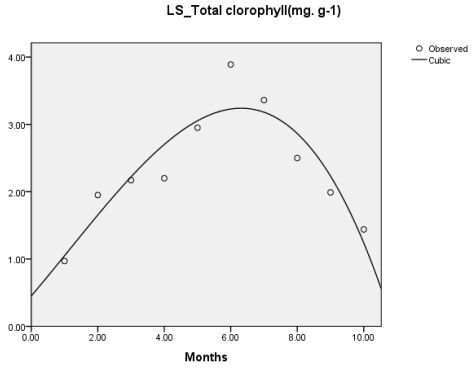

**Figure-1**




**Graph-1**




**Graph-2**




## CONCLUSION

From this study we came to the conclusion that, the chlorophyll content of leaf stratum of Teak plant of Kapilash forest land from the month of April to January including the 3 stages i.e., budding, maturity and senescence, the chlorophyll content increases from April to January in both the leaf stratums and decreases from September upto the next January till the complete leaf fall.

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