International Journal of Science and Research (IJSR)
ISSN: 2319-7064
Impact Factor 2024: 7.101

Decomposition of *Tectona grandis L.* Leaf Litter in a Tropical Semi Moist Deciduous Forest of Gujarat, India

Chandan Kumar Jana

Assistant Professor, Department of Botany, Kandi Raj College, Murshidabad - 742 137 (W. B), India
Email: *chandanjana1971[at]gmail.com*

Abstract: ***The present study was conducted on leaf litter decomposition of Tectona grandis L. in a tropical semi moist deciduous forest of Gujarat. The monthly weight loss of leaf litter of T. grandis L. was carried out by nylon bag technique in the dang forest. The fast rate of decomposition was observed in the rainy season which was favorable climate for microbial activities. Decomposition constant (k) of leaf litter was 1.31 and turnover time required to decompose the residual litter was 323 days. Tectona grandis was found to be most suitable tree species for plantation programme in dry tropical regions as it has high litter deposition and decomposition rates and thus it has advantages in degraded soil restoration and sustainable land management.***

Keywords: *Tectona grandis*, decomposition constant (k), Dang forest, turnover time and macro nutrients release

1. Introduction

Tectona grandis L. is the most important valuable timber yielding plant in the Dang forest of Gujarat. Litter decomposition is an important phenomenon and its study is necessary for understanding nutrient cycling and primary production in the forest ecosystem. Amount of nutrients delivered by annual litterfall to the soil through decomposition is a great importance factor for sustainable forest production and provides an index of forest productivity (Yang Wan - Qin *et al.,* 2006). The rate of decomposition is usually rapid initially but gradually slow down depending upon the physicochemical properties of litter, the condition under which decomposition is taking place and the activities of microorganisms (Daubermire and Prusso 1963). Decomposition is a fundamental process of ecosystem functioning because it is a major determinant of nutrient cycling. The rate of plant decomposition and nutrient release varies with a number of factors, "including rainfall, temperature, soil moisture and the nature of plant material" (Singh *et al.,* 1999). Many workers from different countries have studied on litter decomposition (Hayes 1965; Singh and Gupta 1977; Gupta and Singh 1981; Witecamp1963; Gallardo and Merino 1993,) In the present study, leaf litter decomposition of *Tectona grandis* was carried out inside Dang forest under environmental conditions.

Study Sites:
The present study was carried out in the dang forest of Gujarat. It was situated at the border of Maharastra and Gujarat. It lies between the parallels of latitude 20° 33' 40'' and 21° 30'26'' the meridians of longitudes 72° 27'58'' and 73° 56' 36''. The forest is classified as a South Indian tropical moist deciduous forest type by Champion and Seth (1968). The study was conducted from April 2007 to March 2008. May is the hottest month with maximum temperature about 44° C & December is the coldest month with 16° C temperature. The average annual rainfall is 1998.8 mm. The forest is dominated by *Tectona grandis, Terminalia tomentosa* and *Dalbergia latifolia.*

2. Materials and Methods

Weight loss of leaf litter and the determination of litter decomposition rate was carried out by the nylon litter bag technique (Witkamp 1963; Weigert and McGinnis 1975, Sharma and Ambasht, 1987). Freshly fallen leaves of *T. grandis* plant species were collected in the month of April, 2007. Fifty gram (50g) of air dried leaf litter samples were kept in each litter bags (18cm X 10cm in size). Total 36 such type of bags with leaf litter were placed on forest floor. Every month 3 bags were removed randomly from forest floor and brought to the laboratory. The samples were oven dried at 80° C for 48 hours to estimate the dry weight. The rate at which litter decays under study conditions can be expressed as a constant (k). Olson (1963) assumed the weight loss as an exponential decay and expressed by the following equation.

Xt/Xo = e - kt where X is the weight remaining at time t
Xo is initial weight. e is base of natural logarithm and K is the decomposition constant.

Turnover time is expressed as the reciprocal of turnover rate 1/K. Nitrogen concentration of leaf litter was estimated by Micro Kjedhal methods described by Pandeya *et. al.* (1968).

3. Result and Discussion

Table - 1 shows the weight loss of *Tectona grandis* leaf litter during the decomposition study. The maximum weight loss of litter was recorded as 8.10 g in the month of August and minimum value 0.40 g in October month. Greater weight loss during rainy season may be due to high percentage soil moisture, temperature and also due to leaching of water soluble substances from the litter mass. Smaller weight loss during summer might be due to high temperature and dry conditions. This is obvious from the positive correlation between the rate of weight loss with soil moisture and rainfall (Moretto *et al.,* 2001; Austin and Vitousek, 2000). After one year decomposition process only 67.60% leaf litter mass of *T. grandis* disappeared from the litter bag of which 31.04%,

21.00% and 16.20% in the rainy, winter and summer season respectively. The time required to decompose the residual litter on the forest floor was 0.88 year (323 days). The decay constant (K) of the species litter was estimated to be 1.31 per year (Table - 2). According to the exponential model 95% of initial weight of litter was decomposed within 2.65 year. The simple regression equation describing the relationships between weight loss and moisture content of leaf in *T. grandis* is as follows:

Y=26.97 +0.048x (r=0.358).

Table 2: Exponential decay parameters for leaf litter of *T. grandis.*

Species	Turnover rate		Time required for decay				Turnover time	
	10 - 2 /Day	Year	50 %		95 %		Day	Year
			Day	Year	Day	Year		
T. grandis	0.31	1.31	223.85	0.61	969.03	2.65	323	0.88

Table 1: Monthly rate of weight loss of *T. grandis* leaf litter in nylon bags placed on the Dang forest floor.

Month	Loss of Wt. (g)	Loss of Wt. (g)		Loss of Wt. (%)		N Content (%)
		Monthly	Progressive	Monthly	Progressive	
April, 07	50.00	- -	- -	- -	- -	0.925
May	47.50	2.50	2.50	5.00	5.00	0.874
June	44.70	2.80	5.30	5.89	10.60	0.850
July	42.60	2.10	7.40	4.69	14.80	0.960
August	34.50	8.10	15.50	19.01	31.00	0.821
September	29.40	5.10	20.60	14.78	41.20	0.707
October	29.00	0.40	21.00	1.36	42.00	0.690
November	28.50	0.50	21.50	1.72	43.00	0.686
December	26.00	2.50	24.00	8.77	48.00	0.669
January, 08	21.60	4.40	28.40	16.92	56.00	0.423
February	19.00	2.60	31.00	12.03	62.00	0.489
March	17.50	1.50	32.50	7.89	65.00	0.509
April	16.20	1.30	33.80	7.43	67.00	0.390

In the present study, high rate of weight loss in the leaf litter of *T. grandis* was related to the initial high nitrogen (N) content in the substrate (Table - 1). Litter with a high N content decomposed rapidly than the species low in nitrogen (Melillo *et. al.1*982; Toky and Singh 1993). During monsoon rapid decay phase was observed due to the microbial population as well as their activities in favorable climatic conditions while it was moderate and very slow in the summer and winter seasons (Verma 1997; Singh 1978). However, in the present study the weight loss showed no significant relationship with temperature. Arunachalam *et. al.* (1996) did not find any significant relationship with the weight loss and temperature. Similar observations were observed in the decomposition of *T. grandis.*

The decay constant (k) for *T. grandis* leaf litter was recorded to be 0.88 whish is lower than that of tropical ecosystem reported by Swift *et. al*. (1979). Verma (1997) obtained higher (k) value at Bhagalpur Daria Land due to high rainfall and optimum temperature. In humid tropical forest higher turnover rate was observed by Arunachalam *et. al. (*1996). The value of decay constant (k) in temperature ecosystems was very low than that in tropical ecosystems. In a tropical ecosystem the value of decay constant was as high as 5.0 (Swift *et. al.1*979) due to high rainfall and optimum temperature. In the present study decay constant (k) was 1.31 which was lower than the values reported of teak plantation (2.97) and Savanna (2.74) by Singh (1978). The present (k) value is higher than the value of (k=0.92) reported by Subrahmanyam (1997) in Gir dry deciduous forest of Gujarat. Verma (1997) studied the mix herbaceous leaf litter decomposition and estimated the decomposition constant (k) as 3.4. The lower value of k (1.31) in *T. grandis* may be due to the cellulose, lignin and tannin content in this tree species. These substances are known to control the decay rate by their own resistance to enzymatic attack (Alexander 1977). Many studies have reported a decline in the rate of weight loss of litter due to high initial lignin content (Ribeiro *et al,..2*002). The increase concentration of Nitrogen in decomposing litter could be due to addition of nitrogen through precipitation (Das and Ramkrishnan 1985). In the present study, the rapid decomposition of *Tectona grandis* leaf litter was observed due to soil moisture and nitrogen content of litter. The study revealed that *Tectona grandis* is a suitable tree species for plantation in dry tropical regions as it has high litter deposition and decomposition rates and thus it has advantages in degraded soil restoration and sustainable land management.

Acknowledgement:
Authors are grateful to Dr. B. R. Pandit retired Professor of Life Sciences department in the Bhavnagar University, Gujarat for his valuable discussion in this study. We are also thankful to Forest officer of Dang forest for his moral support during study period.

References

[1] Alexander, M. (1977). Introduction to soil Microbiology.2nd Ed. Wiley, New York.
[2] Arunachalam, A, Maithani, K. Das, A. K. Pandey, H. N. and Tripathi, R. S. (1996). Decomposition dynamics of *Quercus dealbata* (Hook. F. and TH) leaf litter in two Regrowing subtropical humid forest stands in Meghalaya. Ecol. Env and Cons.2 (87 - 91).
[3] Austin, A. T. and Vitousek, P. M.2000. Precipitation, decomposition and litter decomposability of *Metrosideros polymorpha* in active forest on Hawaii. Journal of Ecology 88: 129 - 138.

[4] Champion, H. G. and S. K. Seth (1968). A review survey of forest types in India. Manager of Publications, Govt. of India. New Delhi.
[5] Daubermire, R. & Prusso, D. C. (1963). Studies of the decomposition rates of tree litter. Ecology, 44: 589 - 592.
[6] Das, A. K. and Ramakrishnan, P. S. (1985). Litter dynamics in Khasi pine (*Pinus khasiya*) of north - east India. Forest Ecology and Management, 10, pp 135 - 153.
[7] Gallardo, A. and Merino, J.1993. Leaf decomposition in two mediterranean ecosystems of south - west Spain: influence of substrate quality. Ecology 74: 152 - 161.
[8] Gupta, S. R. and Singh, J. S. (1981). The effect of plant species, weather variables and chemical composition of plant material on decomposition in a tropical grassland. Plant and Soil, 59: 99 - 117.
[9] Hayes, A. J., (1965). Studies on the decomposition of coniferous leaf litter. I. Physical and chemical changes. J. Soil Sci., 16: 121 - 140.
[10] Melillo, J. N., Amber, J. D. and Muratore, J. F. (1982). Nitrogen and lignin control of hardwood leaf litter decomposition dynamics. Ecol., 63: 621 - 626.
[11] Moretto, A. S., Distel, R. A. and Didone, N. G.2001. Decomposition and nutrient dynamic of leaf litter and roots from palatable and unpalatable grasses in semi - arid grassland. Applied Soil Ecology.18: 31 - 37.
[12] Olson, J. S. (1963). Energy storage and the balance of producers and decomposers in ecological systems. Ecology, 44: 322 - 331.
[13] Pandeya, S. C., Puri, G. S. and Singh, J. S. (1968). Research methods in plant ecology. Asia Publishing Home, Bombay.
[14] Rebeiro, C., Maderia, M. and Araujo, M. C.2002. Decomposition and nutrient release from leaf litter of *Eucalyptus globulus* grown under different water and nutrient regimes. Forest Ecology and Management 171: 31 - 41.
[15] Sharma, E. and Ambasht, R. S.1987. Litterfall, decomposition and nutrient release in an age sequence of *Alnus nepalensis* plantation in the Eastern Himalaya. Journal of Ecology 75: 997 - 1010
[16] Singh, J. S. and Gupta, S. R. (1977). Plant decomposition and soil respiration in terrestrial ecosystems. The Botanical Review, 43: 449 - 528.
[17] Singh, K. P., Singh, P. K. and Tripathi, S. K.1999. Litter fall, litter decomposition and nutrient release patterns in four tree species raised on coal mine spoil at Singrauli, India. Biology and Fertility of Soils 29: 371 - 378.
[18] Subrahmanyam, S. V. S. (1991). Production, Decomposition, Mineral status and Calorific value of litter in tropical dry deciduous forest ecosystem. Ph. D. Thesis Bhavnagar University. Bhavnagar.
[19] Swift, M. J., Heal, O. W., and Anderson, J. M. (!979). "Decomposition in Terrestrial Ecosystems. Studies in Ecology", Vol.5. Univ. of California Press, Berkeley.
[20] Singh, A. K. (1978). Comparison of primary production and energetics of Savanna and Teak (Tectona grandis L.) plantation of Chandraprabha region. Ph. d. Thesis. BHU, Varanashi, India.
[21] Toky, O. P. and Singh, V. (1993). Litter dynamics in short - rotation high density tree plantations un an arid region of India. Agriculture, Ecosystems and Environment, 45: 129 - 145.
[22] Verma, H. K. (1997). Mixed leaf litter decomposition in Daira land of Ganga basin at Bhagalpur, Bihar. The Indian Forester.123 (1): 83 - 86.
[23] Witkamp, M. (1963). Microbial population of leaf litter under different Woodland condition. Plant and soil, 9: 179 - 185.
[24] Weigert, R. G. and J. T. McGinnis (1975). Annual production and disappearance of detritus on three South Carolina fields, Ecol., 56: 129 - 140.
[25] Yang Wan - Qin., Wang Kai - Yun., Kellomak, S. and Zhang Jian.2006. Annual and Monthly variations in litter Macronutrients of Three Sub alpine Forest in Western China. Pedosphere 16 (6): 788 - 798.