Weight Loss Of Dalbergia Latifolia Roxb. Leaf Litter and Releasing of Macro Nutrients in Dang Forest Ecosystem of Gujarat, India

Chandan Kumar Jana*
Assistant Professor, Department of Botany, Kandi Raj College, Murshidabad-742137 (W.B)

Abstract:

Dalbergia latifolia Roxb. commonly known as Indian rosewood. It is the most valuable timber yielding plant in India. Litter decomposition of plants dead material provides a source of energy and nutrients in forest ecosystem. It is a fundamental ecological process that recycles nutrients, maintains soil fertility and supports the functioning of terrestrial ecosystems. The present study was carried out to evaluate monthly weight loss of D. latifolia leaf litter during decomposition process by nylon litter bags in the Dang forest floor. Every month weight loss of leaf litter was recorded and releasing of macronutrients such as Na, N, P and K were estimated during decomposition of litter. The fast rate of litter decomposition was observed in the rainy season which was favourable climate for microbial activities. After one year decomposition process only 27.80% D. latifolia litter was remained in the litter bag. Decomposition constant (k) of leaf litter was 1.28 and turnover time required to decompose the residual litter was 323 days.

Key words: Litter decomposition, Dalbergia latifolia, Macronutrients, Turnover time.

Introduction:

Dalbergia latifolia is the most valuable timber yielding plant in India. The decomposition of forest litter is essential for maintaining forest ecosystem productivity and improving soil fertility. Studies on litter decomposition are an important phenomenon for understanding of energy flow, nutrient cycling and primary production in the forest ecosystem. Litter decomposition also plays a key role in carbon cycling and climate regulation. It is a fundamental ecological process that recycles nutrients, maintains soil fertility and supports the functioning of terrestrial ecosystems. This process involves a complex interaction of biotic factors, including decomposers like bacteria, fungi and soil invertibrates and abiotic factors such as temperature, moisture and soil texture. Approximately 90% of the net primary production of terrestrial ecosystems is recycled through the plant litter decomposition that fall to the soil, including leaves, branches, and reproductive structures of plants (Graca et al. 2007). Leaf decomposition varies among species and it is related to chemical composition, particularly to C, N, P, and lignin content and their stoichiometry (Xuluc et al.2003; Ostertag et al. 2008,Talbot and Treseder, 2012). The rate of decomposition which is rapid at first but gradually

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slow down depending upon the physico-chemical properties of litter, the condition under which decomposition is taking place and the activities of micro-organisms (Daubermire and Prusso,1963). It is observed that very few studies were conducted on litter decomposition in the tropical and temperate forest ecosystems. Hence, comprehensive studies on litter degradation have to be undertaken in order to understand the turnover rate of nutrients and other elements in this sensitive ecosystem. (Singh and Gupta 1977; Gupta and Singh 1981; Witcamp 1963). In the present study the rate of leaf litter decomposition in D. latifolia have been carried out under forest environment conditions. Releasing pattern of macro nutrients was also studied.

Study area:

The present study was carried out in the Dang forest of Gujarat. It is known for its extensive and dense forest with Burmese teak plants. The forest plays a significant role in the lives of the tribal communities. It is situated at the border of Maharashtra and Gujarat. The Dang Forest lies between the parallels of North latitudes 20^0 33’ 40” and 21^0 05’ East longitude 73^0 27’ 58” and 73^0 56’ 36”. The Dang district has a geographical area of 172366 hectares, with forest covering about 59.74% of the total area. The area is known for its hilly terrain. The forest type according to the classification by Champion and Seth (1968) is South Indian Tropical moist deciduous forest. May is the hottest month with maximum temperature about 44^0C and December is the coldest month with 16^0C temperature. The average annual rainfall of this district is 1998.8 mm. The forest is dominated by Tectona grandis L., Dalbergia latifolia Roxb. and Terminalia tomentosa Wight & Arn.

Materials and Methods:

Weight loss of leaf litter in D. latifolia was carried out by the nylon litter bag technique (Witcamp 1963, Weigert and McGinnis, 1975). Freshly fallen leaves of D. latifolia plant species were collected in the month of April. Fifty grams (50g.) of air-dried leaf litter samples were kept in each litter bags (18cm x 10cm in size). Total 36 such type of litter 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 clean and oven dried it at 80^0C for 48 hrs.to estimate dry weight. The rate at which litter decays under study conditions can be expressed as a constant (k). The decomposition rate constant (k) was determined with the negative exponential model by the following equation.

$Xt/X_0 = e^{-kt}$

Where, Xt/X_0 is the ratio of original mass remaining over time. (k) is the decomposition constant and t is time elapsed in days. Turnover time is expressed as the reciprocal of turnover rate 1/k. From the (k) values, we estimated the time require to reach 50% and 99% leaf decomposition using following equation (Olson 1963; Arunachalam and Singh, 2002).

-0.693k= t(0.5)-0.693k= t x(0.5)

-4.605k=t(0.99) – 4.605k= t x(0.99)

Where, 0.693 and 4.605 are correction factors for achieving 50 and 99% decomposition (Olson,1963).

t 0.5 = decomposition time of 50% leaf material (year).

t 0.99 = decomposition time of 99% leaf material (year)

k = annual decomposition rate ($year^{-1}$).

Nitrogen concentration of leaf litter was estimated by Micro Kjedhal method described by Pandeya et al.(1968).

Results and Discussion:

Weight loss: Table-1 shows the weight loss of D. latifolia leaf litter during the decomposition study. The maximum weight loss of litter was observed during the rainy season due to the good climatic condition for micro-organisms. The interaction of decomposers, litter quality, and abiotic factors will result in the decomposition of litter, in which the litter is broken down into smaller pieces and finally mineralised into inorganic compounds (Cadish and Giller 1997; Chapman and Koch 2007; Bradford, M. A., et al. 2008**;** Makkonen, M., et al. 2012). According to Swift et al. (1979), the main factors, which influence the litter decomposition, are the litter quality, the physical-chemical environment, and the decomposer organisms; After one year decomposition process only 27.80% litter of D. latifolia was remained in the litter bag. Litter disappearance was observed 12% in summer and 9.6% in winter seasons. The decay constant (k) of this species litter was estimated to be 1.28 per year (Table-2). During monsoon period forest decomposition was recorded high due to the activities of micro-organisms. During the first month after the placement of litter bags in the forest floor, there was a rapid release in the concentration of all elements except Na. The mobility of Na concentration was very low throughout the study period. After one year of decomposition, Na content of D. latifolia was released only 12%.

Table-3 shows the loss of different macro nutrients from the decomposition of leaf litter. In the present study, Na was strongly retained compared with other elements in decomposing litter. It may be cause of microbial immobilisation. Upadhyay and Singh (1991) have found the same result of immobilisation of Na in Quercus glauca litter of Himalayan Forest. After one year decomposition process D. latifolia showed only 3% increase concentration and 72% decrease of absolute nutrient mass of N in litter bag. Such an increase in concentration of Nitrogen was also reported by several authors (Will 1967; Sharma & Ambasht 1987 and Bocock 1964). The increase concentration of Nitrogen in decomposing litter could be due to addition of Nitrogen through precipitation (Das and Ramkrishnan 1985). The average release of N in litter bags of D. latifolia was 60.32% in the initial two months of decomposition (i.e May & June). Immobilisation of N was noticed in the D. latifolia species. After immobilisation, N began to release from the litter bags and finally 72% was released. Similarly, Phosphorus and Potassium were released from the decomposing leaf litter (Table-3). The accumulation phase of Phosphorus was notified after first two months of decomposition. Half of the initial content of P was lost during monsoon and post monsoon period. Finally, 73.92% and 86.12% of initial content of P and K were released from the D. latifolia leaf litter. A similar trend of decline in concentration of nutrients was found by Gupta and Singh (1977) and Ewel (1976).

In the concentration of phosphorus in D. latifolia was little decreased. Gosz et al.,(1973) reported an increased trend in absolute phosphorus was rapidly lost in the leaf litter due to high rainfall. The present findings are well agreement with the worked of Sharma and Ambasht (1987). The concentration of potassium in leaf litter was decreased very fast during the study period. Among all residual materials, potassium was released very fast from the litter bags of D. latifolia. After one year the content of K in litter bag was declined 86.12%. It may be due to rapid leaching and immobilisation of potassium. Similar observation was made by Maclean and Wein (1978). Therefore, the present results can be useful for the new plantation management in the forest ecosystem. Thus, the forest floor is enriched with nutrients. It may be concluded that the litter production and its decomposition was marked seasonal related to the temperature and rainfall pattern.

Table:1.Monthly rate of weight loss of D. latifolia 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	46.00	4.00	4.00	8.00	8.00	0.874
June	45.30	0.70	4.70	1.52	9.40	0.850
July	40.00	5.30	10.00	11.70	20.00	0.960
August	27.00	13.00	23.00	32.50	46.00	0.821
September	23.00	4.00	27.00	14.80	54.00	0.707
October	21.60	1.40	28.40	6.09	56.00	0.690
November	20.00	1.60	30.00	7.40	60.00	0.686
December	18.20	1.80	31.80	9.00	63.60	0.669
January,08	16.80	1.40	33.20	7.69	66.40	0.423
February	15.20	1.60	34.80	9.52	69.60	0.489
March	14.70	0.50	35.30	3.29	70.60	0.509
April	13.90	0.80	36.10	5.44	72.20	0.390

Table : 2. Exponential decay parameters for leaf litter of D. latifolia.

Species	**Turnover rate**	**Time required for 95% decay**		**Turnover time**	
		Day	Year	Day	Year
D. latifolia	1.28/year	855.47	2.34	285.16	0.78

Table-3: Weight remaining in the litter bags and releasing pattern of macro nutrients (Na, N, P & K) during the decomposition of D. latifolia leaf litter.

Months	Remaining weight (g)	Na %	N %	P %	K %
April, 2007	50.00	0.025	1.51	0.005	0.18
May	46.00	0.032	1.08	0.005	0.09
June	45.30	0.040	1.22	0.004	0.07
July	40.00	0.240	0.92	0.003	0.07
August	27.00	0.430	0.82	0.002	0.03
September	23.00	0.014	0.58	0.002	0.04
October	21.60	0.020	0.50	0.002	0.03
November	20.00	0.020	0.50	0.002	0.03
December	18.20	0.020	0.60	0.001	0.02
January,2008	16.80	0.020	0.40	0.001	0.02
February	15.20	0.023	0.35	0.001	0.02
March	14.70	0.021	0.45	0.001	0.02
April	13.90	0.020	0.44	0.001	0.03

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