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Research Article – Ecology

Pattern of litterfall and return of nutrients in five Oak species of mixed Oak forest of Manipur, North-East India

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Abstract

Litterfall and its nutrient return in five oak species were studied in the mixed Oak forest in Senapati District, Manipur .Litter production was measured by litter trap method. The total annual litterfall was 958.9 g $m^{-2}yr^{-1}$.Leaf and non leaf litterfall comprises 76.7 % and 23.3 % of the total litterfall. Maximum litterfall was found in the month of April (193.5 g m^{-2}) and minimum in the month of July (23.7 g m^{-2}). About 70% of the forest floor was replaced each year with turnover time of 1.42 yr. The amount of nutrient return through leaf litter was found to be maximum in *Q. polystachya* and minimum in *C. indica*. Nutrients (NPK) concentration of leaf litter of five different tree species was varied among different tree species.

Key words: Leaf Litterfall, non leaf litterfall, mixed Oak forest, nutrient return, turnover rate

Introduction

Litter is the material lying on the soil surface composed of dead plants and shed organs. It is an important source for transferring energy from vegetation to soil by the process of decomposition and plays an important role in nutrient cycling in a forest ecosystem. Production of litter and its role in regulating forest ecosystem processes vary with forest age, tree density and basal area (Bray and Gorham, 1964).Studies on litter dynamics in forest ecosystems have been studied by several workers like Rawat and Singh (1988), Visalakshi (1995), Garkoti and Singh (1995), Pandey *et al.* (2006) but there is limited information on litterfall and nutrient return from leaves of five different Oak tree species in the sub tropical mixed Oak forest of Manipur. The present study aims to study the litterfall pattern and nutrient return from leaves of different tree species in the subtropical mixed Oak forest.

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Study Area

The study site is situated in the Kounu Hills, Senapati District at a distance of 25 km from Imphal city which falls at 93°55´E longitude and 24°54´N latitude at an altitude of 941 m from mean sea level. The climate of the area is monsoonic with warm moist summer, a distinct rainy season and cool dry winter. The average annual rainfall of the site is 1131.8 mm. The mean monthly maximum temperature ranges from 22 to 32.7°C and the mean monthly minimum temperature ranges from 4.9 to 22.8 °C. The forest is dominated by *Castanopsis indica, Lithocarpus dealbata, Lithocarpus fenestrata, Quercus polystachya, Quercus serrata and Schima wallichii.*

The tree density of the forest was 2440 trees ha^{-1} and basal area was 29 m^2 ha^{-1}.

Materials and Methods

The litter was measured by placing fifteen litter traps of 1m×1m on the forest floor. Litter was collected at monthly intervals from the traps and brought into laboratory where the sample was sorted out into leaf litter and non leaf litter (twigs, bark, fruits, flowers, seeds etc). The leaf litter was then sorted out according to species. Dry weight of

each component was determined by drying to a constant weight at 80°C. Nutrients like Nitrogen, Phosphorus and Potassium were determined from leaf litter of different five Oak tree species by following standard methods. Total nitrogen was determined by kjeldahl method and phosphorus was estimated by colorimetrically. Potassium by flame photometer. Nutrient return was computed by multiplying the nutrient concentration by the dry weight of annual litterfall.

The turnover rate (k) was calculated indirectly using Olson (1963):

$$K = \frac{A}{A+F}$$

Where A is the annual increment of litter (i,e. annual litterfall) and F is the residual litter biomass. Turnover time (t) is the reciprocal of the turnover rate: t=1/k.

Results

The total annual litterfall amounted to 958.9 g m^{-2}. The monthly total litterfall ranged from 23.7 g m^{-2} (July) to 193.5 g m^{-2} (April) throughout the year (Figure 1). Leaf litter comprises 76.7% of the total litterfall and non leaf (twigs, barks and reproductive organs etc,) in total litterfall was 23.3%. Leaf litterfall was found highest in the month of April and lowest in the month of July (Figure 2).Non leaf litterfall was found maximum in the month of April and minimum in the month of August (Figure 3). Species wise, peak value leaf fall occurred during November-December for *Q. serrata*, March-April for *L. dealbata*, April-May for *L.fenestrata, Q. polystachya* and *Castanopsis indica* (Figure 4). Maximum leaf litterfall occurred during the summer season in all dominant tree species but in *Q. serrata* highest leaf litterfall was found in winter season(Table 1). Annual leaf litterfall varied significantly among the different tree species. It ranged from 20.61 to 140.93 gm^{-2} yr^{-1} and followed the order of *Q. polystachya> L. dealbata> Q. serrata> L. fenestrata> C. indica.* The turnover rate of the litter was 0.70 with turnover time of 1.42 yr. Nutrients (N, P, K) concentration from leaf litter of five different tree species were varied among different tree species (Figure 5). The concentration of the nutrients in the leaf litterfall was in the order of N > K > P in all five tree species. Amount of nutrient return through leaf litter was recorded to be maximum in *Quercus polystachya* followed by *L. dealbata, Q. serrata, L. fenestrata* and *Castanopsis indica* (Figure 6).

Figure 1. Total litterfall in mixed oak forest

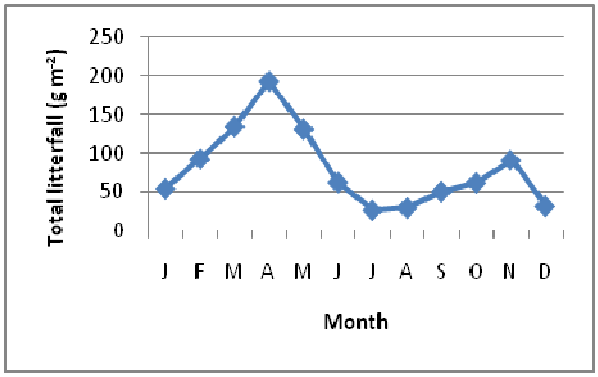


Figure 2. Monthly leaf litterfall in mixed Oak forest

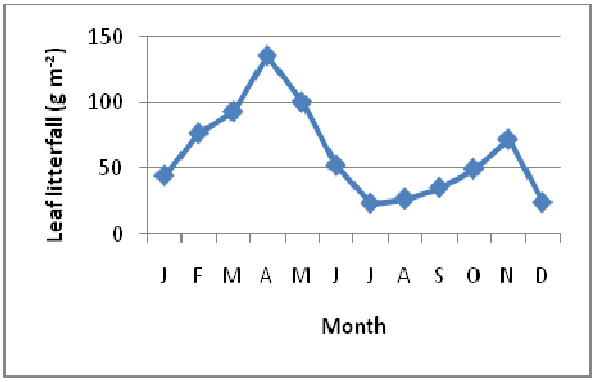


Figure 3. Monthly non leaf litterfall in mixed Oak forest

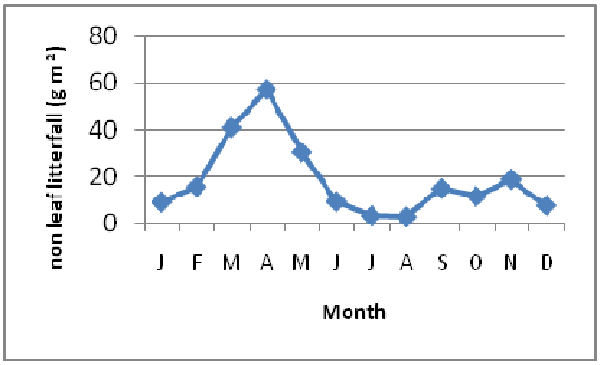


Table 1. Seasonal pattern of litterfall (gm^{-2} yr^{-1}) of five different tree species in mixed Oak forest

Tree species	Summer	Rainy	Winter
L. dealbata	34.25	7.79	10.51
L.fenestrata	18.39	4.35	3.12
Q. polystachya	66.32	44.16	30.45
Q. serrata	15.98	2.12	29.71
C. indica	9.14	6.82	4.65

Figure 4. Monthly leaf litterfall of the five dominant Oak tree species in the study site

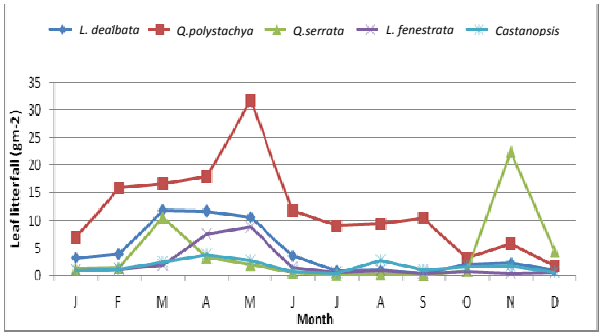


Figure 5. Nutrient concentration (%) of leaf litter of five different tree species

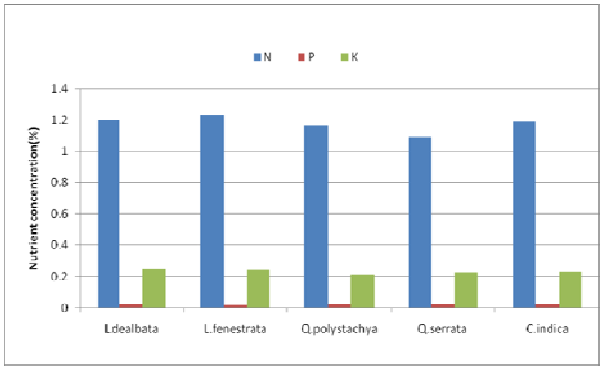
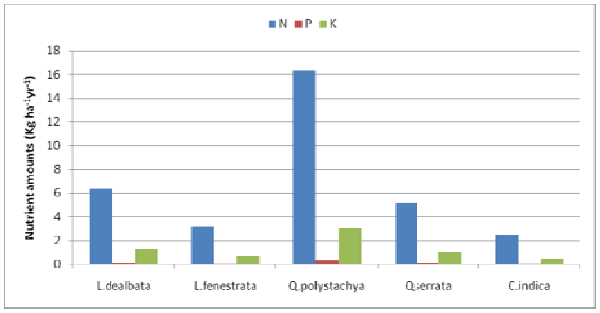


Figure 6. Amount of nutrients return (kg ha^{-1} yr^{-1}) through leaf litter of different five tree species



Discussion

The litterfall pattern shows seasonality. Maximum litterfall occurred during the summer season and minimum during the rainy season. Maximum litterfall during summer season may be due to warm, drier conditions prevailing during that period. The total annual litterfall (9.58 t ha^{-1} yr^{-1}) falls within the ranged reported by Misra and Nisanka (1997) for Casuarina forest (8.6-29.6 t ha $^{-1}$ yr^{-1}) but lower than the value reported by Alvarez and Guevara (1993) for lowland tropical rainforest (20.1-24.2 ha^{-1}). Table 2 compares the ranges of annual litterfall found in the present study with that of different forest ecosystem of the world. The leaf litter comprises for 76.7% of the total litterfall which is within the range reported by Rawat and Singh (1989). The turnover rate of the present study indicated that 70% of the forest floor is replaced each year. The turnover time of the litter was 1.42 years which falls within the ranged reported by Rawat and Singh (1989). The forest floor is characterized by a high replacement rate. Amount of nutrient return through leaf litter was found maximum for *Q. polystachya* which may be due to higher quantity of litter contributed by *Q. polystachya* than that of the other four species. The relative abundance of the nutrients in the leaf litterfall was in the order N>K>P which was similar with the findings reported by Singh and Singh (1992), Garkoti and Singh (1995).

Table 2. Annual litterfall (t ha^{-1} yr^{-1}) for different forest ecosystem of the world

Forest	Location	Litterfall	Reference
Oak forest	Central Himalaya, India	4.7-7.8	Rawat and Singh (1989)
Oak forest	India	2.58-5.61	Gupta and Rout (1992)
Lowland tropical rain forest	Mexico	20.1-24.2	Alvarez and Guevara (1993)
Maple forest	India	6.28	Garkoti and Singh (1995)
Casuarina forest	India	8.6-29.6	Misra and Nisanka (1997)
Lowland rain forest	Nigeria	12.45	Odiwe and Muoghalu (2003)
Oak forest	India	4.19-5.47	Pandey *et al.* (2007)
Oak forest	India	2.58-5.61	Garkoti (2014)
Mixed Oak	India	9.58	Present study

The leaves are the most important fraction of total litterfall, representing 76.7% which is the main vector of potential return of all nutrients to the soil. Non leaf represented 23.3 % of the total litterfall. This study of litterfall can be useful for improving both silvicultural and environmental approaches for the management of this mixed oak forest.

Acknowledgement

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References

Anderson, J.M. and Ingram, J.S.I. (1993). Tropical Soil Biology and Fertility. A handbook of methods. CAB International, Wallingford, UK.

Andivia, E. *et al.* (2010). Nutrients Return from Leaves and Litterfall in a Mediterranean Cork Oak (*Quercus Suber* L.) Forest in Southwestern Spain. *Eur. J. Forest Res.,* 129: 5-12.

Bray, J.R. and Gorham, E. (1964). Litter production in forests of world. *Advances in Ecological Research,* 2: 101-157.

Facelli, J.M. and Pickett, S.T.A. (1991). Plant litter: Its dynamics and effects on plant community structure. *Botanical Review,* 57: 1-32.

Garkoti, S.C. and Singh, S.P. (1995). Forest Floor Mass, Litterfall and Nutrient Return in Central Himalayan High Altitude Forests. *Vegetatio* 120: 33-48.

Garkoti S.C. (2014). Litter Production and Nutrient Return in Three Different Aged Regenerating White Oak (*Quercus leucotrichophora* A. Camus) Forests in the Central Himalaya. *International Journal of Ecology and Environment Sciences,* 40(2-3): 139-148.

Kutbay, H.G. and Horuz, A. (2001). Litterfall and Nuttient Return In *Quercus Cerris* L. Var. Cerris Forests in the Central Black Sea Region of Turkey. *Pak. J. Bot.,* 33(3): 293- 303.

Lang, G.E. (1974). Litter dynamics in a mixed oak Forest on the New Jersey Piedmont. *Bull. Torrey Bot. Club,* 101: 277-286.

Liu, C., Westman, C.J., Berg, B. and Kutsch, W. (2004). Variation in litterfall - climate relationships between coniferous and broadleaf forests in Eurasia. *Global Ecol. Biogeograph,* 13: 105-114.

Misra, M.K. and Nisanka, S.K. (1997). Litterfall, Decomposition and Nutrient Release in Casuarina Equisetifolia Plantations on the Sandy Coast of Orissa, India. *Tropical Ecology,* 38(1): 109-119.

Odiwe, A.I. and Muoghalu, J.I. (2003). Litterfall dynamics and forest floor litter as influenced by fire in a secondary lowland rain forest in Nigeria. *Tropical Ecology,* 44(2): 241-249.

Olson, J.S. (1963). Energy storage and balance of producers and decomposers in ecological systems. *Ecology,* 44: 322-331.

Pandey R.R. *et al.* (2007). Litterfall, Litter Decomposition and Nutrient Dynamics in a Subtropical Natural Oak Forest and Managed Plantation in Northeastren India. *Forest Ecology and Management,* 240: 96-104.

Patricio M.S., Nunes L.F. and Pereira E.L. (2012). Literfall and Litter Decomposition in Chestnut High Forest Stands In Northern Portugal. *Forest Systems,* 21(2): 259-271.

Pragasan, L.A. and Parthsarthy, N. (2005). Litter production in tropical dry evergreen forests of south India in relation to season, plant life-forms and physiognomic groups. *Current Science,* 88: 1255-1263.

Rawat, Y.S. and Singh J.S. (1989). Forest Floor Biomass, Litter fall and Nutrient Return in Central Himalayan Oak Forests. *Vegetatio,* 82: 113-125.

Regina, I.S. and Tarazona T. (2001). Organic Matter and Nitrogen Dynamiocs in a Mature Forest of Common Beech in the Sierra De La Demanda, Spain. *Ann. For. Sci.,* 58: 301-314.

Regina, I.S. (2000). Organic Matter Distribution and Nutrient Fluxes Within a Sweet Chestnut (*Castanea sativa* Mill.) Stand of the Sierra De Gata, Spain. *Ann. For. Sci.,* 57: 691-700.

Sanchez, J.A. and Sada S.G. (1993). Litterfall Dynamics in a Mexican Lowland Tropical Rain Forest. *Tropical Ecology,* 34(2): 127-142.

Singh, K.P., Singh, P.K. and Tripathi, S.K. (1999). Litterfall, Litter decomposition and nutrient release patterns in four native tree species raised on coal mine spoil at Singrauli, India. *Biology Fertility of Soil,* 29: 371-378.

Sundarpandian, S.M. and Swamy, P.S. (1999). Litter Production and leaf-litter decomposition of selected tree species in tropical forests at Kodayar in the Western Ghats, India. *Forest Ecology and Management,* 123: 231-244.

Tangjang, S. *et al.* (2015). Litterfall, Decomposition and Nutrient Dynamics in Traditional Agro-Forestry Systems of Northeast India. *International Journal of Ecology and Environmental Science,* 41(1-20): 43-53.

Upadhyay, V.P., Singh, J.S. and Meentemeyer, V. (1989). Dynamics and weight loss of leaf litter in central Himalayan forests Abiotic *versus* litter quality influences. *J. Ecol.,* 77: 147-161.

Visalakshi N. (1993). Litterfall, Standing Crop of Litter and their Nutrients in Two Tropical Dry Evergreen Forests in India. *International Journal of Ecology and Environmental Sciences,* 19: 163-180.

Vitousek, P.M. (1984). Litter fall, nutrient cycling and nutrient limitation in tropical forests. *Ecology,* 65: 285-298.

Wang Q., Wang S. and Huang, Yu. (2008). Comparisons of Litterfall, Litter Decomposition and Nutrient Return in a Monoculture Cunninghamia Lanceolata and a mixed Stand in Southern China. *Forest Ecology and Management,* 225:1210-1218.

Yang, Y.S., Guo, G.F., Chen, G.S., Xie, J.S., Cai, L.P. and Lin, P. (2004). Litter fall, nutrient return and leaf litter decomposition in four plantations compared with a natural forest in subtropical China. *Annals of Forest Science,* 61: 465-476.