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Short communication

Decomposition of wild jack (*Artocarpus hirsutus* Lamk.) leaf litter under subcanopy and open conditions

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Abstract

A comparative study on *in situ* and *ex situ* decomposition dynamics of wild jack (*Artocarpus hirsutus* Lamk.) leaf litter was conducted in a homegarden of Southern Kerala, India. Results of the litter bag study indicate that under the canopy 95% of the litter mass disappeared in about 17 fortnights, whereas in the open it took approximately 19 fortnights. Weight loss followed a negative exponential model and the half-lives were 9.45 and 10.31 fortnights respectively for *in situ* and *ex situ* decomposition. Earthworm and microbial counts were also substantially greater in the subcanopy than in the open, implying a favourable effect of the subcanopy conditions. Nutrient dynamics exhibited temporary phases of immobilization for both N and P, while K release was continuous.

Key words: decay rate, homegardens, immobilization, nutrient release

Nutrient return via litter decay has long been recognized as the primary pathway for nutrient cycling in tree-based ecosystems. The relative value of leaf litter as a source of nutrient, however, is dependent on its decomposition rate, which in turn, controls the release of the tissue-held mineral ions. Although tree species abound in the Kerala homegardens (Kumar et al., 1994), information on their litter decomposition dynamics is rather scanty. Hence, the present investigation was conducted with the objective of assessing the decomposition pattern and nutrient release from the leaf litter of wild jack tree *(Artocarpus hirsutus* Lamk.*)*, an important component of the traditional homegardens of Kerala.

The experiment was laid out in a homegarden of Kalliyur Panchayath in Thiruvanthapuram District, Kerala during April 1998. The site (40 m above mean sea level, 8.5° N and 76.9° E) experienced a warm humid tropical climate and soil belonged to the Oxisol group. The annual rainfall during the year of study was 1619 mm. Freshly fallen leaves of wild jack tree were collected from the homegarden during the summer months of March-April 1998, and air-dried. The dry weight equivalents were determined by oven drying the samples at 70°C for 48h. Five sub-samples of the oven-dried litter were retained for chemical analyses.

The decomposition study was initiated in the subcanopy of a wild jack tree (*in situ*) and in an adjacent open area (*ex situ*) during the last week of April 1998, employing the standard litter bag technique (Bocock and Gilbert, 1957). Nylon bags of size 25 x 20 cm and 4 mm mesh size were filled with 20 g of air-dried litter. Two hundred such bags each were placed in the litter layer beneath the wild jack tree canopy and on the soil surface in the open site (area 10 x 5 m^2). Five samples each were drawn at fortnightly intervals from each site until 95% of the initial mass disappeared. The retrieved litter samples were cleaned by hand to remove the extraneous materials, oven-dried at 70°C for 48 h and weighed. Samples were then powdered and analysed for N (micro-Kjeldhal method), P (vanado-molybdo phosphoric yellow

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Table 1. Variations in earthworm and micro floral population in soil in the open and beneath tree canopy

Month	Earthworm (number m^{-3})		Fungal count ($x10^3$) per g soil		Bacterial count ($x10^6$) per g soil		Actinomycetes ($x10^4$) per g soil	
	Open	Beneath canopy	Open	Beneath canopy	Open	Beneath canopy	Open	Beneath canopy
May'98	9.20	11.80	11.00	19.40	12.80	15.40	6.40	8.40
June'98	10.00	16.80	11.80	23.40	18.40	18.00	6.20	7.00
July'98	14.40	23.80	13.20	27.60	14.80	19.80	4.80	7.40
Aug.'98	22.40	30.80	20.00	33.00	16.80	39.20	6.60	11.00
Sept'98	27.80	35.60	22.80	33.20	21.60	44.60	11.80	16.40
Oct'98	31.80	36.60	19.40	25.20	22.00	48.80	12.40	17.20
Nov'98	23.20	27.40	16.80	27.40	19.00	35.40	15.80	20.20
Dec'98	22.80	27.40	12.80	23.40	22.00	29.80	18.80	17.60
Jan'99	15.20	15.40	11.80	16.60	18.20	27.00	16.20	18.00
Feb'99	14.60	11.60	10.80	13.60	14.80	21.40	15.40	21.60
Mar'99	11.00	-	15.69	-	16.40	-	16.40	-
CD(0.05)	C: 0.82	P: 1.84 CP : 2.60	C: 0.94	P: 2.11 CP: 2.98	C: 0.95	P: 2.12 CP- 3.01	C:0.66	P:1.47 CP:2.07

C – condition (open/beneath tree canopy); P – period; CP – condition x period interaction

colour method) and K (flame photometry) following Jackson (1958). Lignin in litter was determined by the acid detergent fibre method of Sadasivam and Manikam (1992).

Earthworm (number per cubic metre of soil volume) and microbial populations (bacteria, fungi and actinomycetes) were estimated in the soil samples taken from beneath the litter bags. Dilution plate technique (Parkinson et al., 1971) was employed for estimating the microbial populations. Fungi were cultured in Rose Bengal agar medium; bacteria in soil extract agar medium and actinomycetes in Conn's glycerol asparaginate agar medium; and the colonies counted after incubation at room temperature (28-32°C) for 5, 7 and 12 days respectively and expressed as number per gram of oven-dry weight of soil. The data on nutrient contents in residual litter at the two sites were statistically analysed using the ANOVA technique. The model for constant potential weight loss, represented by the equation,

$$\frac{x}{x^0} = e^{-kt}$$

where x is the weight remaining at time t, x^0 is the original mass, e is the base of the natural logarithm and k, the decay rate coefficient (Olson, 1963), was fitted to the weight loss data. Half-lives ($t_{0.5}$) of decomposing litter were estimated from the k values using the equation

$$t_{0.5} = \frac{ln(0.5)}{-k} = \frac{0.693}{-k}$$

(Bockheim et al., 1991). Nutrient content of decomposing leaf was derived as

$$\% \ Nutrient \ remaining = \left(\frac{C}{C_0}\right) \times \left(\frac{DM}{DM_0}\right) \times 10^2$$

where C is the concentration of the element in litter at the time of sampling; C_0, the concentration of element in the initial litter kept for decomposition; DM, the mass of dry

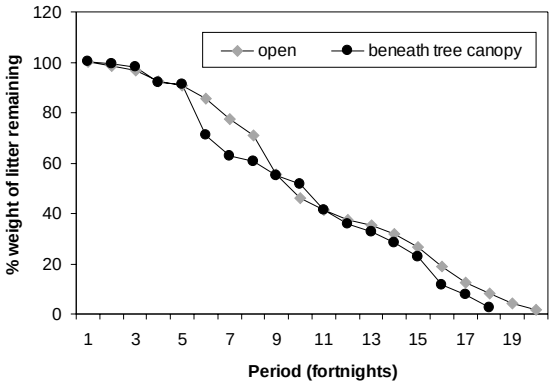

Fig. 1 Weight loss of wild jack (*Artocarpus hirsutus)* leaf litter under open and beneath tree canopy

matter at the time of sampling and DM_0, the mass of initial dry matter kept for decomposition (Bockheim et al., 1991).

The percentages of biomass remaining at fortnightly intervals in the open and subcanopy are presented in Figure 1. Time taken for 95% decay was modestly faster in the latter. For example, the weight loss (95%) was completed in 17 fortnights under *in situ* (subcanopy) conditions, while it took about 19 fortnights in the open. Moreover, the residual litter mass declined exponentially with time at both sites (r^2 values, 0.95 beneath the tree canopy and 0.89 in the open). Half lives ($t_{0.5}$) and fortnightly decay rate coefficients (k) were 9.45 fortnights and –0.073 respectively in the subcanopy and 10.31 fortnights and –0.067 respectively in the open. A 'more negative' *k* value for the subcanopy situation indicates a modestly faster rate of decay there compared to the open. Moreover, the decay rate for wild jack is lower than many other tropical trees (see: Jamaludheen and Kumar, 1999). This is thought to be because of the relatively higher lignin content of wild jack leaf litter (28.7%). For instance, leaf litter of jack tree (*Artocarpus heterophyllus*), another prominent homegarden component, had a lignin concentration of only 15.18% (Isaac and Nair, 2002). Furthermore, litter with more than 15% lignin is generally regarded as of poor quality (Chesson, 1997).

In addition to substrate quality, microclimate and composition of soil organisms are major determinants of litter decomposition (Swift et al., 1979). The higher, albeit modest, decay rates observed in the subcanopy, can probably be explained based on the favourable influence of overstorey on microclimate, besides its impact on the soil biota. The data presented in Table 1 clearly suggest that the populations of microflora and earthworms were higher under the tree canopy. Among the various species of organisms, fungi and bacteria were important from the start of the study, while actinomycetes became dominant

Table 2. Nitrogen, phosphorus and potassium concentrations in wild jack leaf litter at fortnightly intervals on decomposition

Fortnight	Nitrogen (%)		Phosphorus (%)		Potassium (%)	
	Open	Beneath canopy	Open	Beneath canopy	Open	Beneath canopy
0	1.102	1.102	0.049	0.049	0.593	0.593
1	1.244	1.262	0.040	0.046	0.533	0.516
2	1.412	1.412	0.047	0.051	0.531	0.446
3	1.632	1.492	0.066	0.054	0.494	0.860
4	1.606	1.612	0.048	0.053	0.414	0.141
5	1.482	1.410	0.040	0.055	0.405	0.079
6	1.504	1.436	0.031	0.045	0.283	0.059
7	1.418	1.138	0.014	0.040	0.232	0.058
8	1.384	1.128	0.016	0.036	0.194	0.056
9	1.134	1.298	0.021	0.021	0.171	0.049
10	1.042	1.386	0.030	0.023	0.111	0.031
11	0.956	1.026	0.076	0.019	0.100	0.042
12	0.790	0.874	0.109	0.026	0.062	0.024
13	0.568	0.734	0.060	0.040	0.054	0.023
14	0.540	0.632	0.052	0.052	0.052	0.023
15	0.388	0.514	0.048	0.031	0.050	0.023
16	0.494	0.436	0.034	0.020	0.042	0.010
17	0.322	0.412	0.023	0.008	0.036	0.008
18	0.310	-	0.014	-	0.022	-
19	0.198	-	0.008	-	0.012	-
CD(0.05)	C: NS	P: 0.118	C: 0.003	P: 0.010	C: 0.009	P: 0.027
	CP: 0.166		CP: 0.014		CP: 0.038	

C – condition (open/beneath tree canopy); P – period; CP – condition x period interaction

during the later stages. The conspicuous decline in litter mass remaining under the tree canopy during September-October can, thus, be explained based on the higher soil faunal and floral activities during these months.

Elemental composition of decomposing litter revealed an initial increase in the first two months followed by a decrease (Table 2). This is consistent with the reports of Jamaludheen and Kumar (1999) and the increase is probably due to microbial immobilisation, because of the wide C/N ratio. The final release is due to mineralisation of the element as the C/N ratio got lowered. N and P showed a more or less similar pattern in this respect. The increase can be attributed to immobilisation of the element by microbes and the final decrease due to mineralisation (Stohlgren, 1988). Potassium in the litter, however, decreased continuously as decomposition proceeded. As potassium in the plant is not a structural component and being highly mobile, it was probably lost from the litter by leaching. A two-phase pattern of release, characteristic to the element was observed in this respect– an immediate and rapid loss in the early stages followed by a gradual decline during the final stages.

The slow decay and hence the persistence of the wild jack litter promises its use as an efficient organic material for mulching. Furthermore, litterfall production in wild jack being continuous (Jamaludheen and Kumar, 1999), it may provide a regular source of organic inputs into the homegardens, which will help maintain their productivity.

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