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PRIMARY PRODUCTION OF PLOTS OF FIVE YOUNG CLOSE-SPACED FAST-GROWING TREE SPECIES, III. DRY MATTER AND NUTRIENT CONTENT OF LITTERFALL

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ABSTRACT

Biomass of litterfall was measured in *Eucalyptus camaldulensis, Leucaena leucocephala, Cassia siamea, Azadirachta indica* var. *siamensis* and *Acacia auriculaeformis* plots at Ratchaburi Nursery Center, Rathchaburi Province. Litterfall in all species peaked in winter between November and February. The nitrogen content of litterfall ranged from 60 t/ha/yr in *A. auriculaeformis* to 21 t/ha/yr in *E. camaldulensis*; Phosphorus from 3 t/ha/yr in *C. siamea* to 1.3 t/ha/yr in *E. camaldulensis.* Potassium, calcium and magnesium contents of litterfall were lowest in the *E. camaldulensis* plots. The concentration of nutrients in foliage litterfall varied between seasons and was lowest at peak fall time. Nutrient concentrations of the 5 species were comparable.

INTRODUCTION

Litterfall is the major pathway for the return of dead organic matter and the nutrients it contains from the above-ground portions of the plant community to the soil. The amount and nature of litterfall are important factors for maintaining soil fertility. There are very few studies of litterfall in plantations in Thailand (PETMAK, 1983; BUNYAVEJCHEWIN, 1987). The aims of the present study were to determine mass and nutrient content of litterfall in 5 young fast-growing tree species plots: *Eucalyptus camaldulensis* Dehnh., *Leucaena leucocephala* de Wit, *Cassia siamea* Britt., *Azadirachta indica* Juss. var. *siamensis* Valeton, and *Acacia auriculaeformis* Cunn.

METHODS

The study plots were the same as those used for studying biomass, which have been described in the previous paper (BUNYAVEJCHEWIN & KIRATIPRAYOON, 1989). Litterfall collection traps were constructed with wooden boardsides with fine nylon net covering the bottom. The rims were horizontal and approximately 0.8 m above the ground. Two 1 × 1 × 0.2 m litter traps were placed in each sample plot (6 traps for each species).

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The litter was collected monthly from June 1983 until May 1986. It was dried at 80°C for 24 hours before weighing. The litterfall was divided into (i) leaves (ii) twigs and fine branches (iii) other parts (amorphous, reproductive parts and bark).

For nutrient analysis, the litterfall collected from April 1985 to March 1986 was separated into four periods: April-June 1985, July-September 1985, October-December 1985 and January-March 1986. The litterfall components were separated, subsampled and finely ground up. Nitrogen was determined by the Kjeldahl method, and phosphorus by the vanadomolybdate method. Potassium was determined by flame photometry. Calcium and magnesium were determined with an atomic absorption spectrophotometer.

RESULTS

Dry Matter of Litterfall

Litterfall biomass of *L. leucocephala* and *E. camaldulensis* was about 320 $g/m^2/yr$ while that for the other 3 species was much more (> 420 $g/m^2/yr$) (Table 1). Leaf litterfall was highest in *A. indica* var. *siamensis* and lowest in *L. leucocephala*. Twigs plus other parts weighed least in *A. auriculaeformis* and *A. indica* var. *siamensis*.

The relative contributions of individual components of litterfall varied between the 5 species. Leaf litterfall was the major component in all species. *E. camaldulensis, L. leucocephala* and *C. siamea* had a similar pattern; leaves were the major component with twigs and 'other parts' next in importance. The component proportions in *A. indica* var. *siamensis* were markedly different from the other species, with leaves making up 80% and twigs 17%. 'Other parts' were only a minor component (< 1%). In the other 4 species, however, 'other parts' contributed from 11% *(E. camaldulensis)* to 29% *(A. auriculaeformis)*. In *A. auriculaeformis*, twigs were only a minor component of litterfall (6%).

The fall of leaves in all species varied greatly between months, with peak fall occurring during the dry season (Figure 1). For all 5 species studied over 3 years, the time of the peak occurred between November and February. The fall of twigs in *E. camaldulensis*, *A. indica* var. *siamensis* and *C. siamea* also tened to be greatest in the dry season but there was no seasonal trend for 'other parts' litterfall. The fall of the 'other parts' component in *C. siamea* reached a maximum from April to May, and in *A. auriculaeformis* from February to April.

Nutrient Concentrations in Litterfall

Nutrient concentration in all species varied seasonally. In *A. indica* var. *siamensis* and *E. camaldulensis*, the nitrogen concentration in leaf litterfall showed a seasonal trend with minima corresponding to the time of peak fall. In this study, the nutrient concentrations were higher in leaf litterfall than in twigs; however, variations

Table 1. Annual litterfall (g/m^2) in 5 species of fast-growing trees.

Species and period	Component			Total
	Foliage	Twig	Other parts	
Eucalyptus camaldulensis				
June 1983 - May 1984	262.63	50.08	16.60	329.31
June 1984 - May 1985	203.33	54.38	32.67	290.38
June 1985 - May 1986	254.61	43.14	61.84	359.59
Mean	240.19	49.20	37.04	326.43
Leucaena leucocephala				
June 1983 - May 1984	228.42	80.68	82.95	392.05
June 1984 - May 1985	157.48	92.98	31.25	281.71
June 1985 - May 1986	156.22	83.70	29.63	269.55
Mean	180.71	85.79	47.94	314.44
Cassia siamea				
June 1983 - May 1984	310.35	71.68	29.31	411.34
June 1984 - May 1985	262.15	77.78	97.90	437.83
June 1985 - May 1986	223.00	67.80	118.44	409.24
Mean	265.17	72.42	81.88	419.47
Azadirachta indica var. *siamensis*				
June 1983 - May 1984	341.71	76.34	2.64	420.69
June 1984 - May 1985	355.85	77.42	3.71	436.98
June 1985 - May 1986	319.37	95.88	2.35	417.60
Mean	338.98	83.21	2.90	425.09
Acacia auriculaeformis				
June 1983 - May 1984	276.80	7.47	160.24	444.51
June 1984 - May 1985	256.37	19.25	108.08	383.70
June 1985 - May 1986	368.50	54.03	138.77	561.30
Mean	300.56	26.92	135.70	463.18

Table 2. Nutrient concentrations (percent of dry mass) in components of litterfall for 5 species of trees.

Species and Component	Nutrient				
	N	P	K	Ca	Mg
Eucalyptus camaldulensis					
Foliage	0.770	0.047	0.532	1.290	0.192
Twig	0.236	0.014	0.594	1.360	0.140
Other parts	0.346	0.038	0.398	0.348	0.120
Leucaena leucocephala					
Foliage	1.807	0.051	0.672	2.342	0.375
Twig	0.553	0.039	0.548	0.470	0.975
Other parts	1.119	0.221	1.344	0.765	0.198
Cassia siamea					
Foliage	1.124	0.056	0.617	2.280	0.165
Twig	0.610	0.037	0.500	1.750	0.160
Other parts	1.761	0.144	1.078	0.910	0.125
Azadirachta indica var. *siamensis*					
Foliage	1.374	0.057	0.782	1.938	0.485
Twig	0.608	0.042	0.836	0.812	0.375
Other parts	N.D.	N.D.	N.D.	N.D.	N.D.
Acacia auriculaeformis					
Foliage	1.286	0.038	0.594	1.585	0.202
Twig	1.138	0.045	0.704	1.530	0.118
Other parts	1.356	0.058	0.711	0.478	0.090

N.D. = not determined.

were found, expecially for potassium (Table 2). Since reproductive structures were the main portion of 'other parts' litterfall in *L. leucocephala, C. siamea* and *A. auriculaeformis*, the concentrations of phosphorus and potassium were higher in this component than in the leaf and twig components. The lowest concentrations of nitrogen and phoshorus in leaves and twigs were found in *E. camaldulensis*.

Table 3. Mean nutrient content of annual litterfall in kg/ha.

Species and component	N	P	K	Ca	Mg
Eucalyptus camaldulensis					
Foliage	18.495	1.129	12.778	30.984	4.612
Twig	1.161	0.069	2.922	6.691	0.689
Other parts	1.282	0.141	1.474	1.289	0.444
Totals	20.938	1.339	17.174	38.964	5.745
Leucaena leucocephala					
Foliage	32.654	0.922	12.144	42.322	6.777
Twig	4.744	0.335	4.701	4.032	8.364
Other parts	5.364	1.059	6.443	3.667	0.949
Total	42.762	2.316	23.288	50.021	16.090
Cassia siamea					
Foliage	29.805	1.485	16.361	60.459	4.375
Twig	4.418	0.268	3.621	12.674	1.159
Other parts	14.419	1.179	8.827	7.451	1.024
Total	48.642	2.932	28.809	80.584	6.558
Azadirachta indica var. *siamensis*					
Foliage	46.576	1.932	26.508	65.694	16.440
Twig	5.059	0.349	6.956	6.757	3.120
Other parts	N.D.	N.D.	N.D.	N.D.	N.D.
Total	51.635	2.281	33.464	72.451	19.560
Acacia auriculaeformis					
Foliage	38.652	1.142	17.853	47.639	6.071
Twig	3.063	0.121	1.895	4.119	0.318
Other parts	18.401	0.787	9.648	6.486	1.221
Total	60.116	2.050	29.396	58.244	7.610

N.D. = not determined.

Nutrient Contents in Litterfall

The nutrient contents of litterfall of all species are given in Table 3. Generally, the relative contributions of components to the total varied with the mass of litterfall. In *L. leucocephala* and *C. siamea* plots, however, the 'other parts' component contributed 46% and 40% of the phosphorus content of litterfall but only 15% and 20% of the mass, respectively, these due to high phosphorus concentration in 'other parts' litterfall.

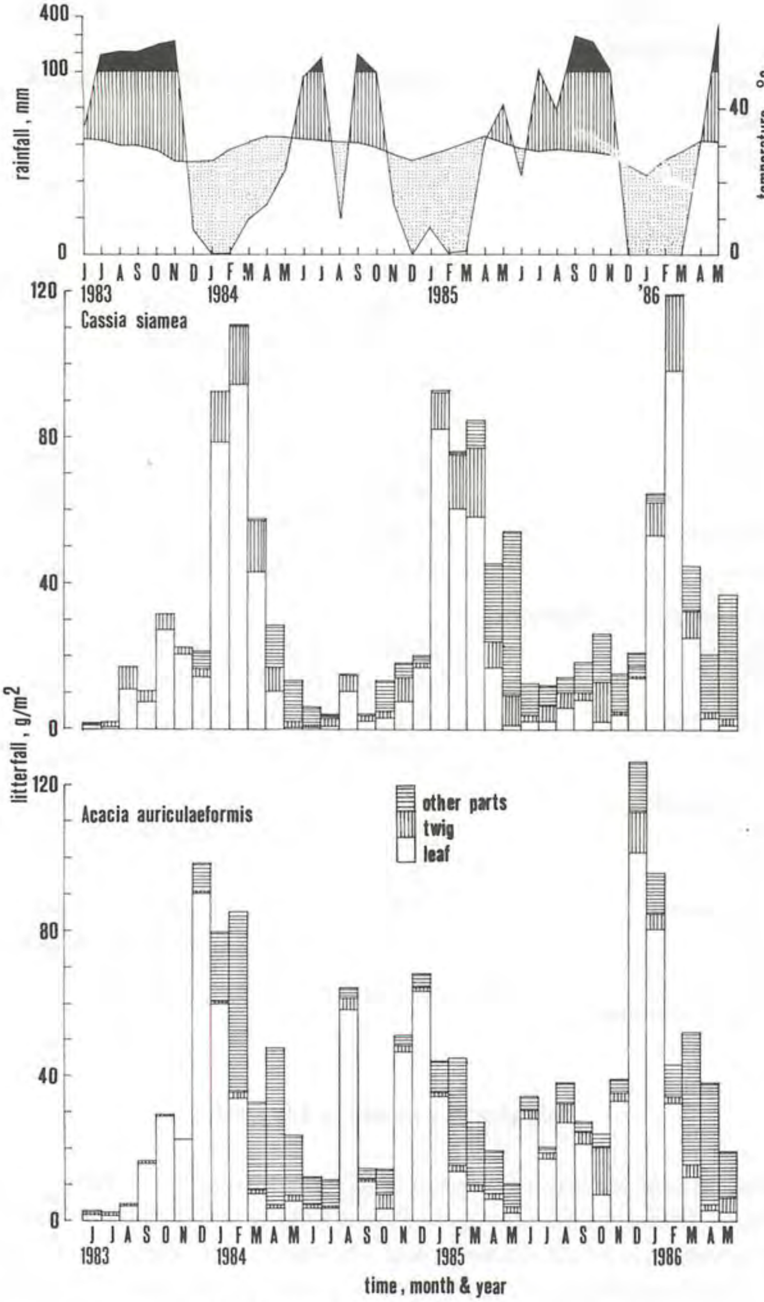
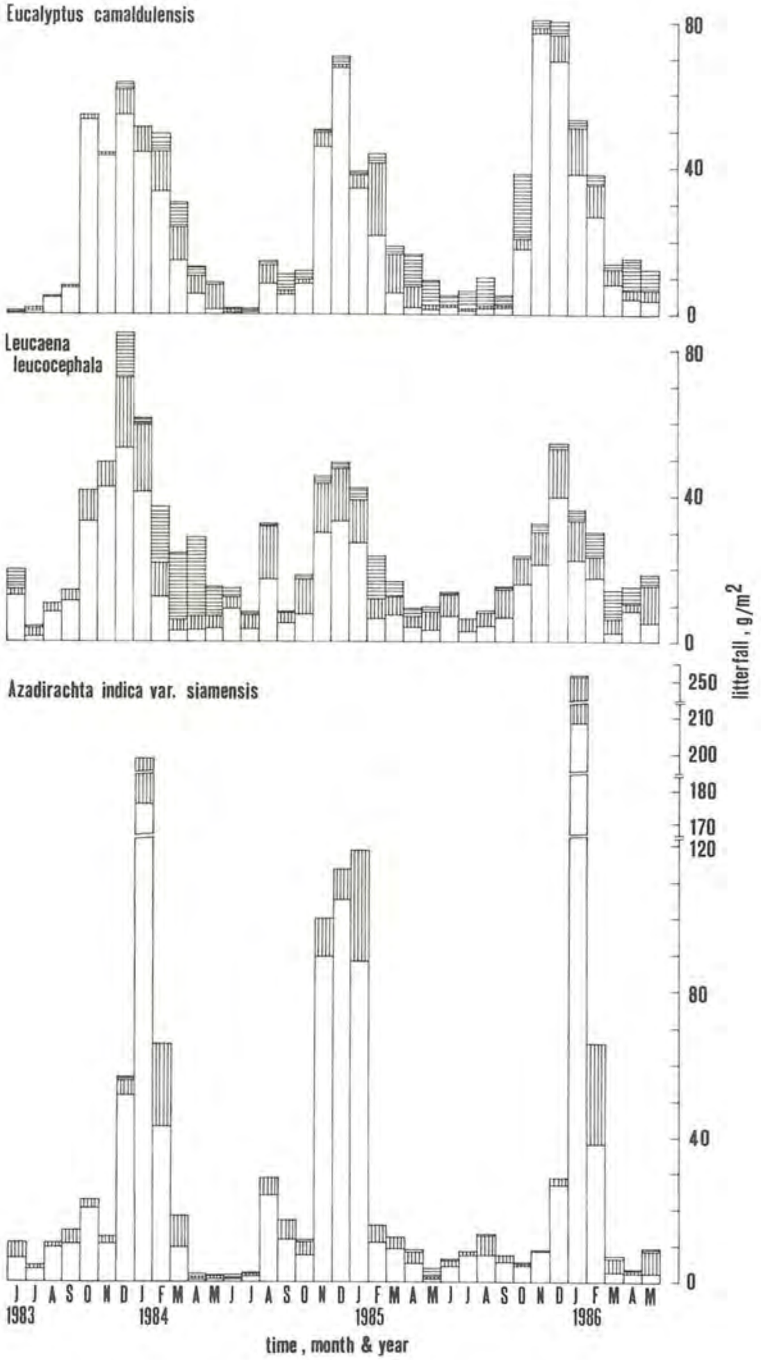


Figure 1. Monthly distribution of litterfall for 5 species.


Eucalyptus camaldulensis
Leucaena leucocephala
Azadirachta indica var. siamensis
80
40
0
250
210
200
180
170
120
litterfall, g/m2
J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M
1983
1984
1985
1986
time, month & year

DISCUSSION

Litterfall in *E. camaldulensis* plots (326 $g/m^2/yr$) in this study was about 35% greater than that found in a previous study by PETMAK (1983); however, the *E. camaldulensis* plots in this study were planted at closer spacing. Although the *E. camaldulensis* plots in the present study were young, the amount of litterfall was close to the litterfall of *E. obliqua* stands aged 80–90 years and spproximately one-half of that in *E. sieberi* stands aged 60 years in Victoria, Australia (BAKER,1983).

Litterfall in *L. leucocephala* plots was found to be greater than that reported in other studies conducted on this species in northeast Thailand (PETMAK, 1983; BUNYAVEJCHEWIN, 1987). No published data on litterfall of *C. siamea*, *A. indica* var. *siamensis* or *A. auriculaeformis* could be found.

The seasonal variations of leaf litterfall are typical of those reported for *Eucalyptus* spp. by ATTIWILL *et al.* (1978) and BAKER (1983), and for *L. leucocephala* by BUNYAVEJCHEWIN (1987). Seasonal variation in leaf litterfall nitrogen in *Eucalyptus* spp. has also been reported by ATTIWILL *et al.* (1978) and BAKER (1983). The lowest nitrogen concentration in leaf litterfall of *A. indica* var. *siamensis* and *E. camaldulensis* corresponded to the time of the peak litterfall. Probably at that time most of the leaves had became senescent and nitrogen in the leaves had been translocated to the other parts of the tree, while at non-peak times of the year, leaves in litterfall may not have been fully mature. Leaves may be dropped prematurely from the crown by strong wind without prior nitrogen translocation as occurs during the normal shedding period.

The nitrogen concentration in foliage litterfall of *E. camaldulensis* in this study fell in the range of the nitrogen concentration in litterfall from *Eucalyptus* spp. in Australia and New Zealand (0.4–0.8%) (BAKER, 1983). The concentration of phosphorus in litterfall of *E. camaldulensis* and *A. auriculaeformis* in this study was lower than that of *L. leucocephala, C. siamea* and *A. indica* var. *siamensis*. The differences in concentration of phosphorus in litterfall between these groups are due to the lower absolute requirements of Southern Hemisphere tree species (especially *Eucalyptus* species) for phosphorus than Northern Hemisphere tree species (ATTIWILL, 1981, cited in BAKER, 1983).

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