LITTER DECOMPOSITION AND NUTRIENTS RELEASE DURING DECOMPOSITION IN A HUMID GRASSLAND OF NORTHEASTERN INDIA

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ABSTRACT

The litter decomposition and nutrient release of two dominant grass species Sporobolus indicus (L) R. Br., Leersia Hexandra SW. and mixed grasses was studies by litter bag technique in the humid grassland ecosystem at Imphal, Northeastern India. On ermination of experiment after 12 months, the shoots decomposed from 97.2 to 100% and the roots from 82.9 to 91.8% of different species. The rate of litter decomposition of shoots were higher than roots. The decomposition constant (K) also varied from species to species. It is positively correlated with soil moisture content during the study period. The initial nitrogen, lignin and lignin to nitrogen ratio influenced the rate of litter decomposition. During the process of decomposition the nutrients concentration were decreased considerably except N, which increased in the concentration. More remaining nutrient contents were recorded in the roots than shoots in all the species at the end of the experiment and were in the order of N>P>K.

KEYWORDS

Decomposition, ecosystem, humid grassland, litter, nutrients, turnover, release

INTRODUCTION

The humid grassland is nutritionally conservative and loss of nutrients are minimal. Plant litter material is the main significant source of plant nutrients and plays a major role in the transfer of energy and nutrients. The nutrients are recycled through excretion products, but main recycling is due to the litter decomposition. The decomposition process depends on a range of ecological factors, available nutrient content of the plant material and biological activities of the soil (Taylor *et al*, 1989). The chemical and structural quality of roots and shoots (especially lignin to nitrogen ratio) have been clearly demonstrated to affect the rate of litter decomposition and nutrient availability (Caldwell *et al*., 1985 and Anderson, 1991). The rate of litter decomposition and nutrients release have been studied in different ecosystems throughout the World (Singh and Gupta, 1977; Devi and Yadava, 1989; Singh and Chandra, 1989b; Tian *et al.*, 1992b; Jackson and Caldwell, 1993; Mary *et al*., 1993 and Lavelle *et al*., 1993). The objective of this study was to determine the rate of litter decomposition, annual decomposition constant, nutrient release (NPK) through decomposition and nutrient mobility and the influence of initial nitrogen, lignin and lignin to nitrogen radio; and soil moisture content on the decomposition of shoots and roots of a humid grassland ecosystem.

MATERIALS AND METHODS

The litter decomposition studies were done in *Sporobolus indicus* (L) R.Br., *Leersia hexandra* SW. and mixed grasses (other than these two species) through litter bag technique. 5 g samples of shoots and roots of different species were kept in the nylon bags and shoots bags were kept on the soil surface after clipping the above ground vegetation and the roots sample were kept below the soil surface within 0-10 cm depth. The samples were collected at monthly intervals and washed using tape water followed by distilled water on a 100-mesh screen, to remove all the soil particles and dried at 80^0C, weighed and ground into powdered for chemical analysis. The decomposition constant (K) were calculated following the equation given by Olson (1963). The estimation of lignin, nitrogen and phosphorus was determined following the method given by Anderson and Ingram (1989) using BACKMAN -DU R 640 Spectrophotometer and potassium by wet ashing using SYSTRONICS-Flame Photometyer.

RESULTS AND DISCUSSION

Litter decomposition. There were no biomass remains in *L. Hexandra* and mixed grasses except 2.8% remains in the shoot parts of *S. indicus* after the termination of experiment of 12 months. The remaining roots biomass (%) was recorded to be maximum in *S. indicus* followed by *L. hexandra* and mixed grasses (Figure 1). The rate of litter decomposition (per day) was slightly lower in *S. indicus* in comparison to *L. hexandra* and mixed grass samples. The turnover rate (days) or 50% and 95% and annual decomposition constant(D) also varied species to species (Table 1). The rate of litter decomposition was higher at the beginning of the experiment. The litter samples consisted of various compounds with different decomposition susceptibility and it is obvious that litter decomposition promotes faster decaying in the initial period than in later stages (Christenssen, 1986; Collins et al., 1990 and Kanal, 1995). In our study the shoots decomposed faster in comparison to the roots in all species which may be due to higher microbial activities on the soil surface than inside the soil as well as other abiotic factors influencing the rate of decomposition (Singh and Chandra, 1989a; Reid and Deschamps, 1991 and Yadava et al., 1995). The rate of litter decomposition was positively correlated with soil moisture, initial lignin and lignin to nitrogen ratio (Table 2) and also agrees with the work of Tian et al.(1992b.). Santantonio and Grace (1987) also suggested that temperature and moisture contents of soils are the main abiotic factors influencing the litter decomposition.

Release of nutrients through litter decomposition. The nitrogen concentration was considerably increased from the original concentration in both shoots and roots parts. The phosphorus and potassium concentration was decreased considerably, during decomposition in all the species, in all the systems throughout the last stages of decomposition. The proportion of the original amounts of nutrients that were released during one year decreased in the order of K<P<N in both shoots and roots of *L. hexandra*, shoots of *S. indicus* and roots of mixed grass samples; whereas the root of *S. indicus* and shoot of mixed grasses are in the order of P>K>N (Figure 2). Generally, potassium was the most mobile element and phosphorus was strongly retained by the decomposing substances; whereas nutrients were released more rapidly in shoots than in roots in all three species. Present data agrees with other studies reported on correlating initial chemical properties with mass loss (Palm and Sanchez, 1990; Constantinides and Fownes, 1993; Myers *et al*., 1994 and Vitousek *et al*., 1994). The major contribution of N in crop residues, particularly low-quality gramineous residues, is through the soil organic matter and there is considerable variation in the partitioning of residue N between plants and soil organic matter (Ng Kwee Kuong *et al*., 1987 and Janzen *et al*., 1990). The low initial nutrients concentration recorded in *S. indicus*, indicates more remaining nutrient contents on the termination of the experiment from other two grass species. The litter with low-quality of nutrients would be released at a time of plant need. Whereas, with high-quality litter, nutrients were released rapidly, initially in excess of plant demand and there was the risk of a nutrient such as N being lost through leaching or denitrification or a nutrient such as P becoming chemically unavailable (Swift, 1987). The removal of grassland frequently provides suitable condition for the processes through which nutrients may be lsot from the soil and the slow rate of decomposition in root would be advantageous because the effective life of the residue would be extended. Results of this study indicate that factors other than N content interact with it to control decomposition of grasses, whereas the amount of NPK available for decomposition is important from the stand point of microbial metabolisms, the nature of the material being decomposed is also important where some competition between groups of soil organisms for nutrients exists. Thus a high NPK content should be desirable for decomposition.

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Table 1
Rate of litter decomposition, turnover rate and annual decomposition constant of different species during litter decomposition

Name of species	Rate of decomp. (% per day)	Turnover rate (days) 50%	95%	Decomp. constant (K)
Shoots				
S. indicus	0.27	188	357	1.95
L. hexandra	0.29	174	330	1.94
Mixed grasses	0.29	174	330	1.96
Roots				
S. indicus	0.22	230	438	1.89
L. hexandra	0.23	214	406	1.91
Mixed grasses	0.23	217	413	1.93

Table 2
Correlation coefficient (r) between rate of litter decomposition and soil moisture (%) of soil (N=12), remaining biomass and initial nitrogen, lignin and lignin to nitrogen ratio (N=9)

Name of species	Moisture content	Nitrogen	Lignin	Lignin: Nitrogen
Shoots	–	-0.73*	0.82***	0.88***
S. indicus	0.77***	–	–	–
L. hexandra	0.83***	–	–	–
Mixed grasses	0.80***	–	–	–
Roots	–	-0.89***	0.92***	0.99****
S. indicus	0.67**	–	–	–
L. hexandra	0.73***	–	–	–
Mixed grasses	0.75***	–	–	–

* Significant at P > 0.05; ** P > 0.02; *** P > 0.01 and **** P > 0.001.

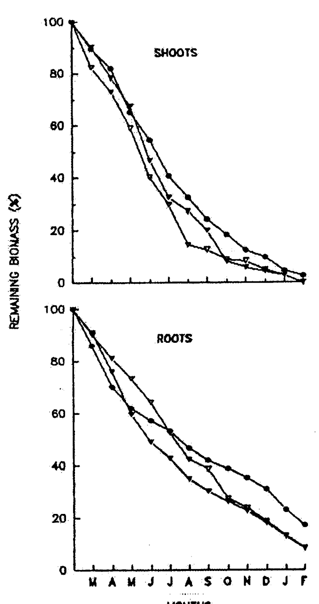

Figure 1
Percentage of original biomass remaining after varios period of decomposition of different species
(• *S. indicus*; *L. hexandra*; ◀ *Mixed grass*)

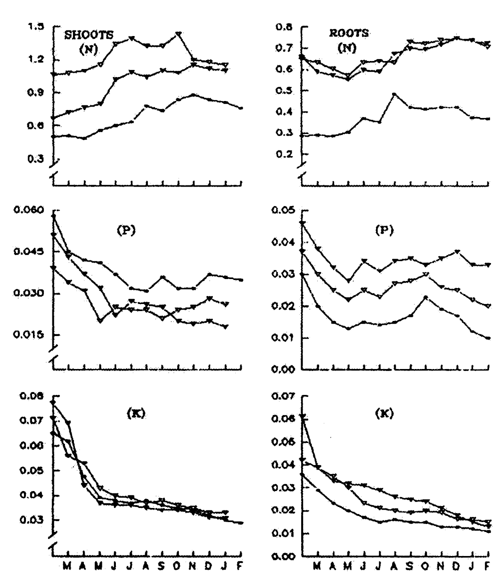

Figure 2
Release of nutrients concentration (N P K) from litter decomposition of different species
(• *S. indicus*; *L. hexandra*; ◀ *Mixed grasses*)