SEASONAL VARIABILITY OF LITTER DECOMPOSITION IN RONDONIA STATE

G.M. Cabianchi[1]

A.V. Krusche[1]; N.K. Leite[1]; M.V.R. Ballester[1]; R.L. Victoria[1]; G.G. Baldi[1]; V.M.G.B. Trigueirinho[1]

1-Universidade de São Paulo, Centro de Energia Nuclear na Agricultura, Laboratório de Análise Ambiental e Geoprocessamento, Av. Centenário, nº 303, 13400 - 970, Piracicaba, São Paulo, Brazil. Phone number: 55 19 3429 4063- giovanamc@cena.usp.br

---

INTRODUCTION

In several forest ecosystems senescent leaf deposition represents an important source of nutrients, influencing essential processes within these systems. Leaf litter nutrients become available to communities through decomposition processes.

Decomposition maintains forest ecosystems structure and function, mainly at the tropics, which are strong - dependent on the internal recycling (Olson, 1963; Odum, 1983). In Brazil, nutrient cycling studies in native forests have revealed that Amazon rainforest is one of the most oligotrophic forests in the World, with soils extremely acidic and exhibiting low fertility levels (Santana *et al.*, 003).

Several factors and their interactions influences decomposition speed, among them, soil moisture, temperature, litterfall chemical composition, soil nutritional state, and soil biota (Reynolds & Hunter, 2001).

According to Malanson (1993), decomposition is strongly associated to moisture, corresponding to the most important factor for litter decomposition in riparian areas. This author also enunciates that decomposition rates usually decreases from riparian to upland areas (due to the high water availability in the former), and also states that as higher the frequency between transitioning dry and wet seasons higher the potential to release nutrients from litterfall.

Moreover, tropical ecosystems, such as Amazon forest, exhibit litterfall production and litter decomposition both related to seasonal patterns as function of climatic conditions along the year (Luizão, 1982). Since the highest production is found at the driest period, decomposition processes exhibit an inverse pattern, decreasing during this season (Luizão & Luizão, 1991).

Among the methods employed to assess decomposition of litter layer one may cite direct evaluations of mass which is lost from nylon bags (litterbags) and also the ratio between the quantity of material falling from canopy to the litter stock; from both is possible to calculate the coefficient k. The k value has been largely used to evaluate litterfall decay rate or renewal time of this layer; the only requirement is that it must be employed only in steady - state systems (Olson, 1963).

There are few studies working with litter decomposition in riparian forests in Amazonia, particularly for riparian fragments, which represents a new fact on the local landscape.

OBJECTIVES

Hence, the purpose of this study was to evaluate the litterfall decomposition dynamics in a riparian forest in southwestern Amazon region.

MATERIAL AND METHODS

2.1 - Field Collections

The study was conducted on a 2 ha parcel covered by tropical ombrophilous forest, located in the Urupá River basin. The parcel is limited by the Urupá River and by an adjacent pasture area. This site is situated about 25 km far from the city of Ji - Paraná, central Rondônia, southwestern Amazonia.

The regional climate is moist tropical, with temperature and mean annual precipitation of 26^{0}C e 2,200 mm/yr, respectively. This region exhibits a well defined seasonality, where dry season comprises the months from May through September (when precipitation not exceeds 50 mm/month) and the rainy season from October through April. The soils are classified as Ultisols with averaged texture, and granulometry predominantly sandy (60 to 80%), with clay and silt increasing with depth.

The decomposition rate assessment was calculated using the litterbags technique. In order to carry out the experiment senescent leaves were used, since they comprise about 70% of produced litter in our study area, and several authors agrees that these are the most important litterfall fraction for nutrient cycling studies. The material was stored on nylon bags, with reasonable mesh size in order to allow fauna access and avoid leaching losses.

The experiment was divided into two phases, 6 months each, in order to sample the most representatives climatic seasons (wet and dry). 10 monthly replicas were collected, totalizing 120 samples. The first phase comprised the months from January to June, 2008, and the second one, from July 2008 to January 2009.

2.2 - Processing of the collected material

In the lab, the material was slightly washed, in order to remove attached residues. After this procedure the material was taken into the oven for drying at 60^0C until reaching to a constant weight (usually after 50 hours) and then weighted to achieve the dry weight.

2.3 - Data processing

Leaf litterfall decomposition rate was calculated according to the simple negative exponential model proposed by Olson (1963): Xt / X0 = e - kt, where Xt represents the dry weight of residual material after t days, X0 is the dry weight of the initial material, t is the residence time in the field (as years), e is the natural logarithm base and k is the decomposition constant. This model describes the decomposition process, where the constant k expresses its speed. A high k value indicates a faster speed in this process.

We also calculated the mean residence time of litter in the soil or turnover, which is the inverse of k (1/k), being expressed as months or years (Moro *et al.*, 996); and the time needed for the disappearance of 50% of the litter (half - life), assessed by Shanks & Olson (1961) equation: T0,5 = - ln 0,5/k.

The statistical analyses were conducted by the program SAS 9.1. After model presupposition was verified, data were submitted to analysis of variance followed by T - test ($p < 0.05$) in order to test statistical differences between seasonal periods (dry vs. wet).

RESULTS AND DISCUSSION

In general, decomposition process showed a distinct pattern for each season: rainy exhibiting a faster decomposition in the first four months, with monthly k values between 1.2 and 1.4, whereas the dry season showed slow mass lost, although during the entire period, with k values varying between 0.6 and 0.9.

According to Toledo (2003), litter decomposition rate is higher at the beginning, when less recalcitrant compounds are used by microorganisms. However, this factor was more pronounced when abundant moisture was available, as observed with mass lost in the first month for both seasons: after the first month exposing the material to wet conditions about 12% of the material was decomposed, whereas after the same situation over the dry season only 6% of material was broken down.

According to Lavelle *et al.*, 1993) and Aerts (1997), dry conditions act directly on decay organisms' metabolism, diminishing their activities and afterwards reducing the mass decay intensity. This pattern could be confirmed by this study: statistical analysis have proven different seasonal patterns acting on the decomposition process between the two periods, confirming the seasonal factor influence in the decomposition process of studied area.

Nevertheless, despite the differences found between the two seasons, when one considers the mass lost percentage during the end of wet season, there was 70.4% against 68.6% of residual mass in the end of the dry season. The clearest difference between the two seasons was the accentuation of decomposition curve between the two periods: during the wettest season the mass lost concentrated in the first months, whereas in the dry season there was a slow and progressive material loss during the entire period.

These results suggest a quick nutrient release followed by vegetation reutilization mainly at the beginning of the wet season, and lower, but constant, during the drier period.

The evaluation of coefficient k indicates that decomposition rates in an annual basis was k = 1.0, showing distinct averages for the first (1.2) and second (0.8) phases.

In the same way, time needed to reach 50% of material lost exhibited a similar pattern for both seasons, being 0.6 and 0.9 years for both wet and dry periods; and the renewal time for the organic layer in the soil surface was 1.1 year on an annual basis, being 0.9 and 1.4 years for both wet and dry seasons.

Summarizing, results suggests an important role of seasonality as controlling factor of local decomposition processes.

CONCLUSION

Although the studied area is a riparian forest, seasonally flooded, the strong seasonality on the rainfall regime does not allow an optimum for decomposition during the entire year, but variations according to the seasons, which was proved by observations performed seasonally, which exhibited lower decomposition rates during the driest period.

(This research was supported by a grant from FAPESP and CNpq/FINEP (proc. 07/52258 - 0 and 505612/2004 - 6, respectively). The authors would like to thanks friends and referees for comments and corrections on the manuscript.)

REFERENCES

Aerts, R. Climate, leaf litter chemistry and leaf litter decomposition in terrestrial ecosystems: a triangular relationship. Oikos, 79: 439 - 449, 1997.

Lavelle, P.; Blanchart, E.; Martin, A.; Martin, S.; Spain, A.; Toutain, F.; Barois, I; & Schafer, R. A hierarchical model for decomposition in terrestrial ecosystems: application to soils of the humid tropics. Biotropica, 25 (2): 130 - 150, 1993.

Luizão, F.J. Produção e decomposição da liteira em floresta de terra firme da Amazônia Central: aspectos químicos e biológicos da lixiviação e remoção dos nutrientes da liteira. INPA/UFAM, Manaus, 1982. 107p. (Dissertação de Mestrado).

Luizão, R.C.C.; Luizão, F.J. Liteira e biomassa microbiana do solo no ciclo da matéria orgânica e nutrientes em terra - firme na Amazônia central. (A.L. Val, R. Figlivolo e E. Fedberg, eds.). In Bases Científicas para Estratégias de Preservação e Desenvolvimento da Amazônia. Secretaria de Ciência e Tecnologia, INPA, Manaus, v. 1, p.65 - 75, 1991.

Malanson, G.P. Riparian landscapes. Cambridge University Press, Cambridge, 1993.

Moro, M.J.; Domingo, F.; Escarré, A. Organic matter and nitrogen cycles in a pine afforested catchment with a shrub layer of Adenocarpus decorticans and Cistus laurifolius in south - eastern Spain. Annals of Botany, v.78, n.6, p.675 - 685, 1996.

Odum, E.P. Ecologia. Rio de Janeiro: Guanabara Koogan, 1983, 434p.

Olson, J.S. Energy storage and the balance of producers and decomposers in ecological systems. Ecology, 44 (2), p.322 - 331, 1963.

Reynolds, B.C.; Hunter, M.D. Responses of soil respiration, soil nutrients, a litter decomposition to inputs from canopy herbivores. Soil Biology and Biochemistry, v.33, n.12/13, p.1641 - 1652, 2001.

Santana, J.A. da S.; Sousa, L.K.V dos S.; Almeida, W.C. Produção Anual de serapilheira em floresta secundária na Amazônia Oriental. Revista de Ciências Agrária, Belém, 40, p. 119 - 132, 2003.

Shanks, R.; Olson, J. First - year breakdown of leaf litter in Southern Appalachian Forests. Sciense, v. 134, p. 194 - 195, 1961.

Toledo, L. de O. Aporte de serapilheira, fauna edáfica e taxa de decomposição em áreas de floresta secundária no município de Pinheiral, RJ. UFRJ. Rio de Janeiro, 2003, 80p. (Dissertação de Mestrado)