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Nutrient fluxes in throughfall and stemflow in forest Cerrado species

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Introduction

Although recognized as a hotspot, being one of the most diverse biomes in Brazil and responsible for recharging the main aquifers in South America, the Cerrado has been suffering from intense deforestation. Since rainfall, after reaching the forest canopy, has its physicochemical features altered by the metabolites leaching from the leaves, branches, and stem, this study was developed in order to obtain information about the hydrological processes in the biome and the potential of nutrient input by their forest species. There is a lack of studies as proposed in natural environments such as Cerrado. Based on this, we have evaluated the relative importance of stemflow and throughfall solute concentrations to the soil surface in a Cerrado forest in Brazil and the potential of stemflow by 8 Cerrado species to soil nutrient input.

Material and Methods

The study was carried out at RPPN Floresta das Águas Perenes, located in the municipality of Brotas, in the state of São Paulo, belonging to International Paper do Brazil Ltda. The RPPN has 809.78 ha and is inserted in the Cerrado Biome and in the last 44 years it was destined to the cultivation of *Eucalyptus* sp.

The experimental dataset was collected within three plots in a 20 m × 20 m plot in the Cerrado fragment. Rainfall, throughfall, and stemflow were measured on an event basis from late August to early December 2018 (springer and summer station). The rainfall samples were collected in the open area, serving as a control for evaluating the extent of chemical enrichment in the throughfall and stemflow drainage.

For the stemflow, the samples were obtained for the 8 species that had the highest number of individuals among the 43 species found in the study area as well as “higher stemflow production”. Hence, the stemflow was measured in 24 trees of the following species (3 individuals/species): *Anadenanthera peregrina var. falcata, Copaifera langsdorffii, Croton floribundus, Handroanthus ochraceus, Handroanthus serratifolius, Syagrus romanzoffiana, Tapirira guianensis,* and *Xylopia aromatica.* The stemflow samples for the individual species were also pooled to create composite samples.

The following chemical factors were determined for rainfall, throughfall and stemflow using a Metrohm liquid chromatograph ECO IC during August to December 2018: Na^{2+}, K^{+}, hardness (Ca^{2+} and Mg^{2+}), Cl^{-}, SO_4^{2-}, PO^{3-} and NO_4^{-}. A comparison between the mean concentrations showed that most of the elements and compounds were relatively more concentrated in the throughfall and stemflow, except for Na^{2+} and Ca^{2+}, which were more concentrated in the rainfall ($p < 0.05$).

Figure 1. Stemflow system construction with a polyurethane gutter (A-E); Rain gauge used to collect the throughfall, Brotas, São Paulo, Brazil.

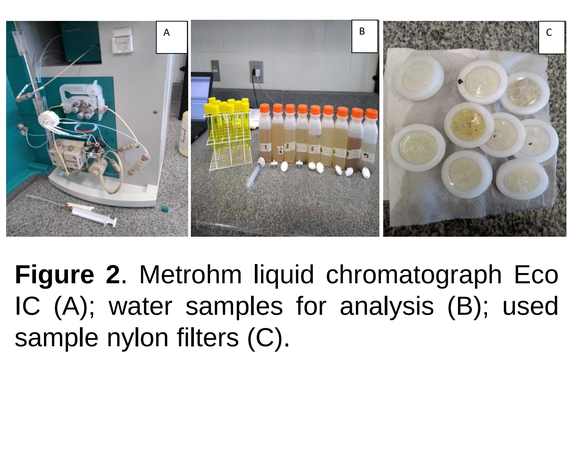

Figure 2. Metrohm liquid chromatograph Eco IC (A); water samples for analysis (B); used sample nylon filters (C).

Results and Discussion

A comparison between the mean concentrations showed that most of the elements and compounds were relatively more concentrated in the throughfall and stemflow, except for Na^{2+} and Ca^{2+}, which were more concentrated in the rainfall ($p < 0.05$).

While the amount of stemflow channeled to the tree trunks comprised approximately 4% of the rainfall, some nutrients in the stemflow were enriched up to 10-fold in comparison to those in the throughfall and rainfall. When we discriminated the solute concentration by stemflow between the 8 forest species from the Cerrado, we noted that each species has a specific contribution to the stemflow nutrients, and for most of the species, the ion concentrations in the stemflow water are higher than those found in the rainfall and throughfall.

Xylopia aromatica showed a major difference in solute concentrations when compared with those of the other species. The total input from the nutrient fluxes, as the amount of rainfall loading, was ranked as follows: $K^{+} > Ca^{2+} > Mg^{2+} > NO_3 > SO_4^{2-} > PO_4^{3-} > Cl^{-} > Br^{-}$. The highest nutrient input by stemflow was for K^{+}, which ranged from 7.91 (*H. ochraceus*) to 114.08 (*X. aromatica*) kg.ha^{-1}.

Conclusion

Given the variety in the nutrient input to the biogeochemical cycle, these results highlight the importance of investigating the individual contribution of the stemflow of each species in the Cerrado forest and provide a potential strategy for adapting the species to soil recovery.

Knowledge of biogeochemical dynamics helps to improve the understanding of the processes that are responsible for the sustainability of forest ecosystems, and forest ecosystems play an important role in water balance, not only in terms of water quantity (i.e., volume) but also in the distribution of chemical elements..

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