BURNING OF TROPICAL BRAZILIAN RAINFOREST OF SANDY SOIL: DOES IT AFFECT SOIL ORGANIC MATTER?

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Abstract. This study aimed to investigate the impact of vegetation burning on the content and chemical composition of soil organic matter (SOM) along a profile of a sandy Acrisol in Southwestern Amazon, Brazil, within 3 years after experiment beginning (YAB). The study was performed in Rio Branco, Acre State, and the forest burning was performed under controlled conditions. Samples from 6 depth (0-100cm depth) were collected under burned forest (BF) and primary forest (PF) at 1 YAB and 3 YAB. Besides C and N contents, humic substances and biomarkers were determined. Under PF, the C content decreased with depth from 12 to 2 g kg^{-1}. C/N ratio ranged from 7.6 at the surface to values around 3 at 1 m depth, indicating a predominance of microbial products. Humin fraction was not detected in the whole profile. Burning of vegetation promoted an increase of C and of humic acids only at 0-5 cm. The *n*-alkane distribution showed a shift towards smaller chains in the 0-5 cm of BF, indicating main contribution of microbial products. Also PAH's of high molecular weight were detected in this site. Vegetation burning imparts alterations on the SOM composition, but these tend to disappear within 3 years.

Introduction

In the Amazon region, burning of the forest, as part of the conversion process to agriculture or pasture, is still common, in spite of the strong control of the Government. Pyrogenic C produced by the fire, due to its aromatic structure, may represent a C pool of small turnover rate and its addition to the soil may increase C sequestration and alter the SOM composition and dynamics. However little is known about the impact of forest burning on the SOM composition and storage in Amazon region. The environmental conditions in this area provide a completely diverse climate from that of subtropical and temperate regions, where the effect of burning on SOM has been reported.

The main goal of this study was to investigate the impact of vegetation burning on the content and chemical composition of SOM along a profile of a sandy Acrisol in Southwestern Amazon, Brazil, within 3 years after experiment implantation (YAI).

Materials and methods

The study was conducted in the experimental station of Embrapa-Agroforestry Research Center, in Rio Branco, Acre state, Brazil. The experiment started in 2011 and an area of 2.25 ha of primary forest was burnt under controlled conditions. In 2012, 1 year after experiment implantation (1YAI) and in 3YAI, samples were collected (three replicates) at the burned forest area (BF) and at the adjacent primary forest (PF) area at six soil layers: 0 - 5, 5 - 10, 10 - 15, 20 - 30, 50 - 75 and 100 - 150 cm. Soil C and N contents were determined by dry combustion and C/N ratio was calculated. Humic substances were fractionated (Swift, 1996), quantified (Dick et al., 1998) and the following fractions were obtained: C_{HCL}, C_{HS}, C_{HA} and C_{FA}. Biomarkers were extracted with a solution of CH_2Cl_2/CH_3OH (3:1; v/v) under reflux using soxhlet extraction. The lipid extracts were further fractionated into *n*-alkanes and polyaromatic hydrocarbons (HPA's), according to their polarity by means of liquid chromatography under atmospheric pressure: These fractions were analyzed by GC/MS. The contents of C, N and humic substances were analyzed by descriptive statistics (average and standard deviation).

Results and Discussion

C content ranged from 1.8 to 17.8 g kg^{-1} and decreased with depth in the two study sites (Figure 1). The larger C values in the 0-5 cm layer observed in BF compared to PF indicated that vegetation burning promoted an increase in SOM only at the surface over 1 year. C/N ratio varied between 8.9 and 7.5 on the surface in both sites. The values decreased with depth and reached around 3.4 at the 100-150 cm layer (Figure 1). These values are typical for biomass and indicate that, regardless the fire, SOM is mainly composed by microbial products. The content of humin along the profile was negligible in both sites, evidencing that SOM was mainly composed by functionalized humic matter. In the surface layer, there was an increase of the C_{HS} and C_{HCl} in 1 YAI compared to PF. Therefore, the

observed increase in C after burning is due to the stimulation of the formation of HS and low molecular weight organic compounds (C_{HCl}). This last fraction is mostly composed of organic compounds derived from root exudates and microbial activity, and the structures are smaller and biochemically more labile than HA and FA.

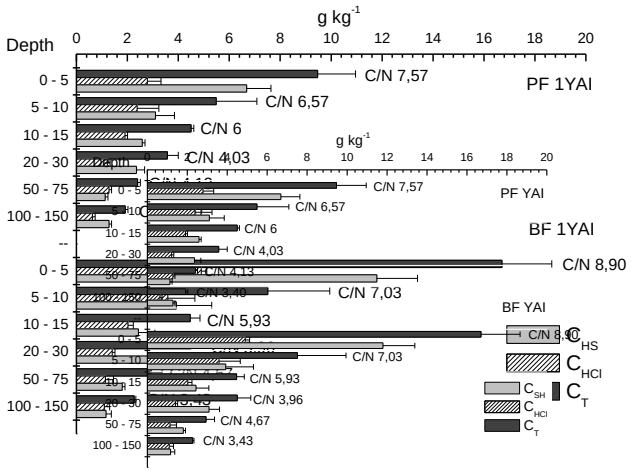

Fig. 1. Contents of soil C, C_{HCL} and C_{HS} and C/N ratio of PF and BF at 1 YAI.

PF sample showed a bimodal distribution profile of *n*-alkanes, with series ranging from C_{17}-C_{31}, (Figure 2A) and predominance of even over odd with maximum at C_{18} and C_{19}. This is a characteristic profile of contribution of both microbial products and higher plants to SOM lipids. BF sample showed unimodal distribution profile and a shift of *n*-alkanes towards smaller chains, with maximum at C_{16}, C_{17} and C_{18}. (Figure 2B). This pattern indicates SOM lipids mainly from microbial origin. However, a break of longer chain *n*-alkanes in smaller units caused by the fire should not be discarded. The samples from the 100-150 cm depth of both sites (Figure 2A and 2B) show a similar distribution profile as the respective 0-5 cm depth samples.

In 0-5 cm BF sample, HPAs of high molecular weight were detected in 1YAI (Figure 3), and these compounds were formed during the vegetation fire. In the 0-5cm PF sample, HPA's were also detected, but in lower amount and of smaller molecular weight. Probably these compounds were formed at BF and transported to the PF site by drift.

The increased content of SOM at 0-5cm depth after forest burning observed within 1 year was found mainly as hydrophilic humic substances. Intense climate conditions, i.e. high rainfall and temperature, cause this rapid humification and efficient mineralization of organic residues. In depth, the SOM is mainly composed by microbial products. It seems that in Amazon region, alterations in the SOM composition due to fire have also a great impact in deeper layers, but tend to disappear shortly.

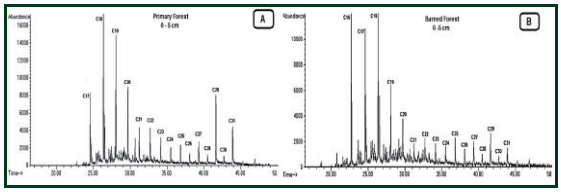

Fig 1. Profile of *n*-alkanes for 0-5 cm samples of PF (A) and BF (B) at 1 year after experiment implantation.

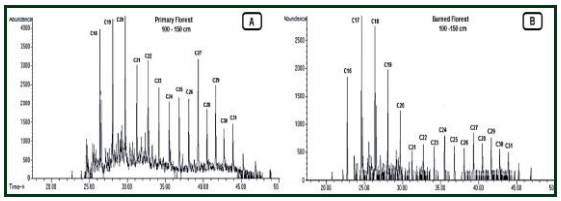

Fig 2. Profile of *n*-alkanes for 100-150 cm samples of PF (A) and BF (B) at 1 year after experiment implantation

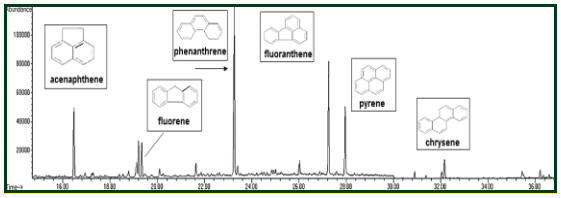

Fig 3. HPA's distribution for 0-5 cm sample of BF at 1 year after experiment implantation

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