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Carbon stocks and organic matter composition in subtropical Oxisols after 8 and 41 years of ceasing fire

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Introduction

At the highland soils, located at the northeastern part of Rio Grande do Sul State, South Brazil, cattle raising is one of the main economic activities. Burning of vegetation at the end of winter has been replaced in the last years by other management strategies like lower grazing intensity and frequency, introduction of new forage species, grassland cutting and soil liming and fertilization. The present work aimed to investigate the effect of pasture management on the quality and stocks of soil organic matter (SOM) of a Red Oxisol. Soil samples (0-5cm) were collected (three replicates) from: non-managed native pasture without burning in the last 41 years and grazed with 1.2 animal ha^{-1} (NP), native pasture without burning in the last 8 years and grazing of 0.5 animal ha^{-1} (BP), native pasture without burning in the last 41 years, grazed with 1.2 animal ha^{-1} and ameliorated by liming and fertilization in the last 17 years (AP) and native forest (NF). Physical fractionation was performed by the densimetric method (politungstate solution, $\rho = 2$ g cm^{-3}) resulting in free light fraction (FLF), occluded light fraction (OLF) and heavy fraction (HF). Carbon and nitrogen contents were determined by dry combustion and carbon stocks were calculated. SOM in physical fractions was investigated by thermo-gravimetric analyses (TGA) between 40 and 800°C under synthetic air and a chemical recalcitrance index was calculated: $\Delta m_{(3^o)} / \Delta m_{(2^o)}$. From the FTIR spectra, relative intensities of the main absorptions were obtained.

Results and Discussions

Soil C stock was greater in the ameliorated pasture (38 Mg ha^{-1}) than in the BP environment (27 Mg ha^{-1}), whilst an intermediate value was found in NP (30 Mg ha^{-1}). This result is related to the higher forage production in the ameliorated pasture in comparison to the non-managed pastures.

Therefore, the greater input of vegetal residues (above and below ground) in the former environment promoted C sequestration in spite of its higher grazing intensity, when compared to the more recently burned pasture.

The same behaviour was followed by C stocks in the physical fractions. The increase in C stocks in the ameliorated pasture in comparison to BP occurred in all three fractions, and the obtained values were 7.0 Mg ha^{-1} for FLF, 4.7 Mg ha^{-1} for OLF and 26.1 Mg ha^{-1} for the heavy fraction. C stocks shown by BP were the smallest ones: 2.2; 3.1 and 21.4 Mg ha^{-1}, for FLF, OLF and HF, respectively. Both light fractions of the BP environment showed high C/N values (28 and 19), indicating the occurrence of a different forage (FLF) and of a more recalcitrant OLF in this environment in comparison to NP and AP. These results were corroborated by the FTIR data, where the lowest intensities of N-H bands were found for OLF and FLF of BP. Additionally, these two fractions showed the smallest relative intensity of the 1630 cm^{-1} band and greatest of the 2920 cm^{-1} band in comparison to their respective counterparts of the other environments. The opposite occurred with the HF. It follows that the forage species developed under BP were more aliphatic and less aromatic than in the other environments. The BP heavy fraction, due to the lower residue input, was enriched in aromatic structures. TGA data confirmed partially these findings.

Conclusions

Fertilizing and Liming of subtropical pastures in South Brazil highlands proved to be an appropriate management strategy to improve soil C sequestration. Ceasing fire, without any subsequent pasture amelioration, deplete C stocks and increase SOM recalcitrance in the heavy fraction.

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