Evaluation of Soil Carbon Sequestration in Brazilian Pastureland

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Keywords: soil carbon sequestration, pastureland, fluorescence spectroscopy

1. INTRODUCTION

Pasture management may increase soil organic carbon (SOC). Recent studies (1) showed that pasture can also be significant in carbon sequestration. The use of spectroscopic methods allows identification of functional groups and molecular structures providing a better understanding of pathways decomposition of soil organic matter (SOM) and qualitative alterations induced by management practices. Fluorescence has been used for evaluating land use and soil management effects on the humification degree (HD) of soil humic acids (HA) (2).

The present study aims to quantify the carbon storage and to evaluate the SOM stability in pastureland soils under different treatments using Fluorescence spectroscopy.

2. MATERIALS AND METHODS

Soil Samples: This study consists in a long-term experiment (26 years) located in São Carlos city, state of São Paulo, Brazil, in the Southeast Embrapa Cattle, on a Brachiaria decumbens pastureland. This work was based on soil samples and some of their respective HA extracted from an Oxisol, with 30% clay. The sampled treatments were: T00 (control): 26 years under pasture; t0: no surface liming, but with mineral fertilization (400 kg y^{-1} N-ammonium sulfate and K_2O); t2m: 2 t ha^{-1} of surface limestone application, with NK fertilization and 1 t ha^{-1} y^{-1} reinforcement of limestone application; t4sa: 4 t ha^{-1} of surface limestone

application without mineral fertilization, as well as original native mesophyle semideciduous tropical forest (ON). The liming treatments were established in 1999, in order to recover the pastureland with great N-input, without burning.

Soil samples were collected in 2003, 2004 and 2005 from different depths: 0-10, 10-20, 20-40, 40-60, 60-80 and 80-100 cm. The total organic carbon (TOC) of these samples was performed using TOC-VCPH Shimadzu equipment coupled with a SSM-5000A solid module. HA samples were extracted and purified according to the International Humic Substance Society (IHSS) methodology.

Fluorescence spectroscopy of HA solutions: Each HA sample, 20 mg L^{-1}, was dissolved in 0.05 M $NaHCO_3$. Fluorescence spectra in emission and synchronous scan modes were recorded on Perkin Elmer LS-50B luminescence spectrophotometer. The HD was calculated according to methodologies (2-4).

3. RESULTS AND DISCUSSION

The C analysis obtained by TOC in different soil treatments: ON, T00, t0, t2m and t4sa at different depths: 0-10, 10-20, 20-40, 40-60, 60-80 e 80-100 cm is shown in Figure 1. The highest value of C was observed in a pasture, mainly in 0-10 cm, where accumulation of plant biomass occurs and C decreases as the depths increase in all treatments.

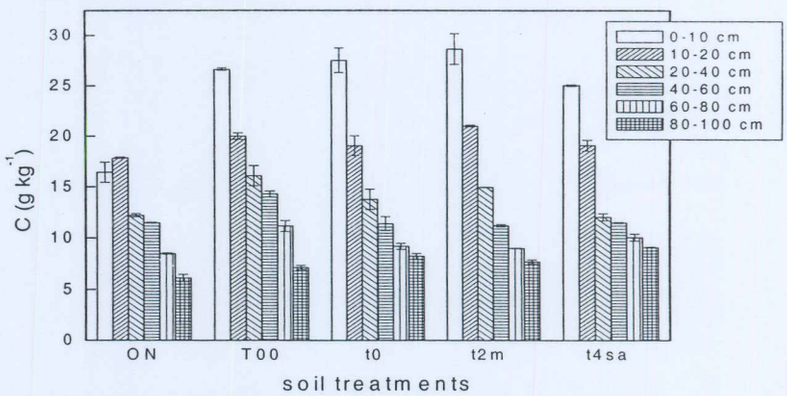

Figure 1: Carbon (C) (g kg^{-1}) analysis in soils measured by TOC.

Figure 2 shows the HD determined by fluorescence spectroscopy, using Milori's methodology (2). The higher HD did occur in t2m and t4sa treatments perhaps due to lime presence. Lime applications are known to increase the soil pH, stimulating soil microbiological activity. In ON and t0, with fertilizers applications, there are some factors that decrease HD: temperature, fresh plant

biomass input and less humidity in soil surface layer due to greater transpiration surface of canopy. The increased plant biomass produced by fertilizers, results in an increasing return of organic material to the soil in the decaying roots form, litter and crop residues (5,6).

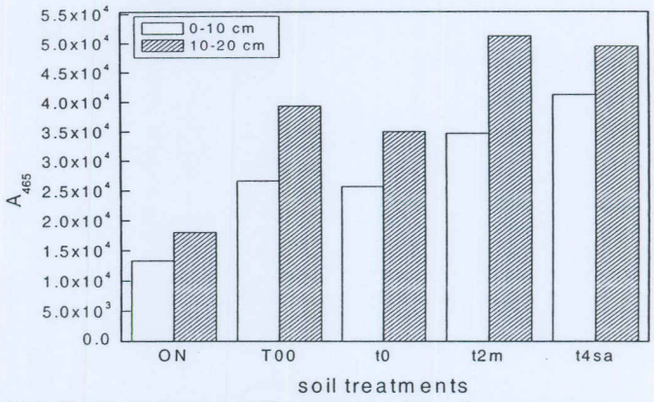

Figure 2: Humification degree (HD) measured by fluorescence, according to Milori's methodology (2). These determination were made under different treatments and depths.

Figure 3 shows the correlation among fluorescence methodologies using HA samples. The linear correlation coefficients obtained were around r=0.85, P=0.001. These results strongly indicate that it is possible to evaluate the HD using fluorescence spectroscopy. Certainly, assessments in HD would have interest for agricultural systems. It is also an accessible analysis of SOM stability, because it measures stable carbon.

4. CONCLUSIONS

The evaluation of the HD is interesting for agricultural systems. This information obtained by fluorescence methods showed a good correlation among HD determined by different fluorescence methodologies. In Brazilian tropical areas, pasture practice could increase SOM compared with other soil use. Greater amount of carbon yield indicates a possible alternative for C sequestration in this management, demonstrating the efficiency of this system in maintaining or even increasing the organic C stock along the years.

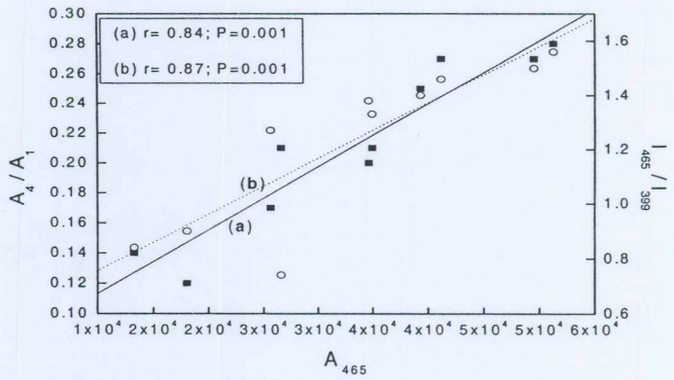

Figure 3: Correlation between humification degree (HD) determined by fluorescence of HA in solution, using Milori's with (a) Zsolnay's (3) and (b) Kalbitz's (4) methodologies.

ACKNOWLEDGEMENTS

Financial support from FAPESP (03/06096-8), Embrapa (01.02.1.03.02.05) and University of São Paulo – IQSC-USP.

REFERENCES

(1) Rezende, C. D. P. et al.: Litter deposition and disappearance in Brachiaria pastures in the Atlantic forest region of the South of Bahia. Nutr. Cycl. Agroecosys, Brazil, 54(2), 99-112 (1999).

(2) Milori, D. M. B. P. et al.: Humification degree of soil humic acids determined by fluorescence spectroscopy. Soil Sci. 167, 739-749 (2002).

(3) Zsolnay, A. et al.: Differentiating with fluorescence spectroscopy the sources of dissolved organic matter in soils subjected to drying. Chemosphere 38(1), 45-50 (1998).

(4) Kalbitz, K. et al.: Spectroscopic properties of dissolved humic substances – a reflection of land use history in a fen area. Biogeochemistry 47, 219-238 (1999).

(6) Haynes, R. J.; Naidu, R.: Influence of lime, fertilizer and manure applications on soil organic matter content and soil physical conditions: a review. Nutr. Cycl. Agroecosys 51, 123-137 (1998).

(7) Primavesi, O. et al.: Calagem em pastagem de *Brachiaria decumbens* recuperada com adubação nitrogenada em cobertura. São Carlos: Embrapa Pecuária Sudeste. Embrapa Pecuária Sudeste, Circular Técnica, 37, 32p. (2004).