SOIL MICROBIAL PROPRIETIES IN TROPICAL INTEGRATED CROP–LIVESTOCK SYSTEM

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Introduction

Soil C sequestration is a viable short–term option to mitigate increased atmospheric CO_2. The complex biological, chemical, and physical interactions resulting in C sequestration need to be evaluated to determine strategies to enhance the ability to sequester C (White and Rice 2009). Strategies to increase soil C involve increasing C inputs or decreasing loses. Increasing plant C inputs include cover crops, and improved crop rotations; no–tillage, in addition to agroforestry systems (AFS).

The introduction of tree species may promote microbial diversity when converting pastures into exotic species forests (Carson et al., 2010). Plants rely on soil microbes to decompose organic matter and make nutrients available for plants. Changes in microbial community could also reversely impact plants aboveground (Frouz et al., 2016). Soil biology is an important component of C sequestration and soil aggregation, as the abundance of arbuscular mycorrhizal (AMF) and saprophytic fungi are often correlated with the mass of macroaggregates (Six et al., 2006). Management practices can alter the composition and function of microbial communities thus affecting soil C dynamics. Bacteria and fungi play a key role in organic matter decomposition (Six et al. 2006). Soil enzyme activities are a sensitive indicator of soil quality and may respond to changes in the soil faster than other soil properties (Medeiros et al., 2015). The proportion of microbial biomass composed of fungi can increase with less soil disturbance (Frey et al. 1999).

Objective

To determine the influence of the eucalyptus silvopastoral systems in comparison with open grassland as well as a native area (savanna), in the Cerrado biome in São Paulo, Brazil on the ability to sequester C.

Material and Methods

Site: Votuporanga, São Paulo State, Brazil (50º 04' W, 20º 28' S and 450 m), For eight years under integrated crop–livestock system, installed in a degraded pasture area since 2009. Soil was classified as Arenic Hapludult (Soil Survey Staff, 2014).
Experimental Design: design was completely randomized, in a 2 × 4 factorial scheme, with four replications.
Treatments: two hybrids of Eucalyptus: Grancam 1277 and Urograndis H–13, and four sampling points: 0 (between the trees), 2, 4 and 6 m of eucalyptus trees in the 0–0.05, 0.05–0.10, 0.10–0.20 m depth. Each depth was analyzed separately, but consisted of subplots at sampling time. In addition, a pasture was used in full sun and native area (Savanna) as reference.
Measuremnents: C and N Stock; Aggregate–size distribution; Extracellular enzyme activities; Total microbial biomass;
Soil microbial communities: Phospholipid Fatty Acid (PLFA).

Figure 1. Integrated crop–livestock system, installed in a degraded pasture area since 2009, at a spacing of 2 × 12 m, density of 370 plants ha^{-1}.

Agroecosystems

Figure 1. Agroecosystems: integrated crop–livestock system; Grassland and native area (Savanna)

Results

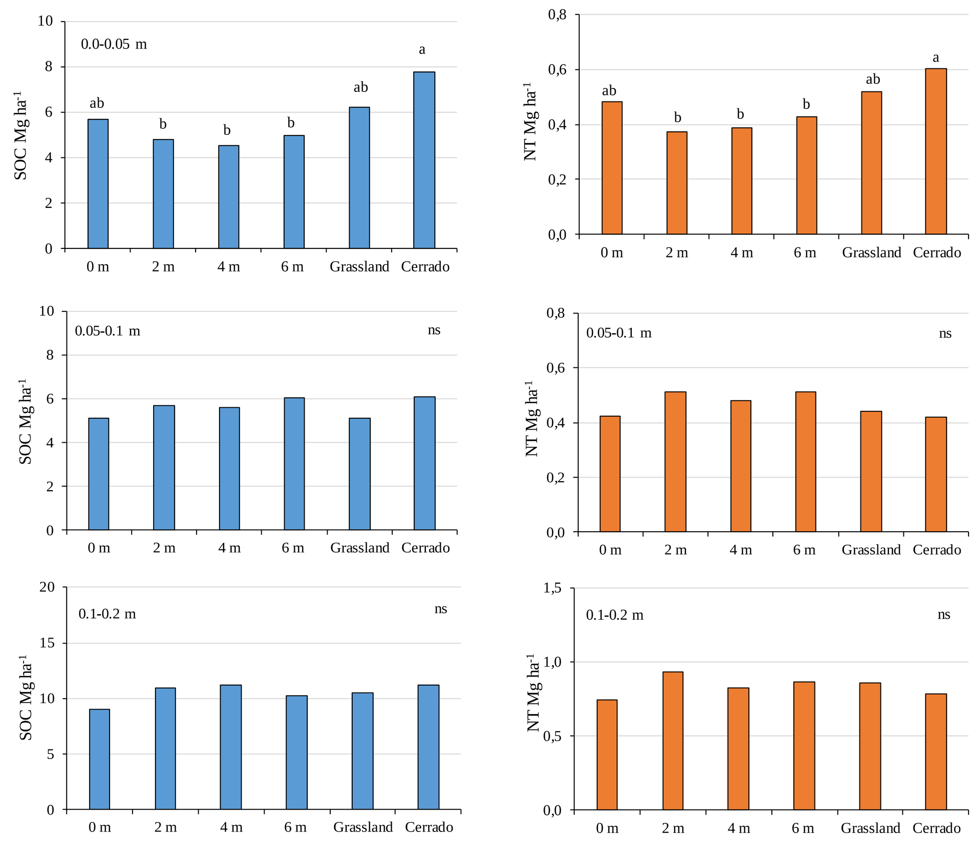

Figure 2. Soil organic carbon (SOC) and nitrogen stocks (NT) in integrated system grassland and native forest Cerrado

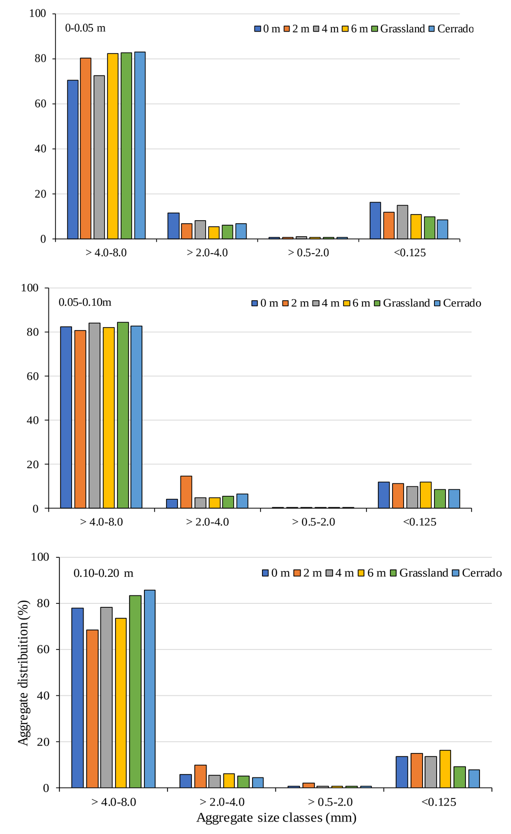

Figure 3. Soil aggregate distribution in integrated system, grassland, and native forest Cerrado

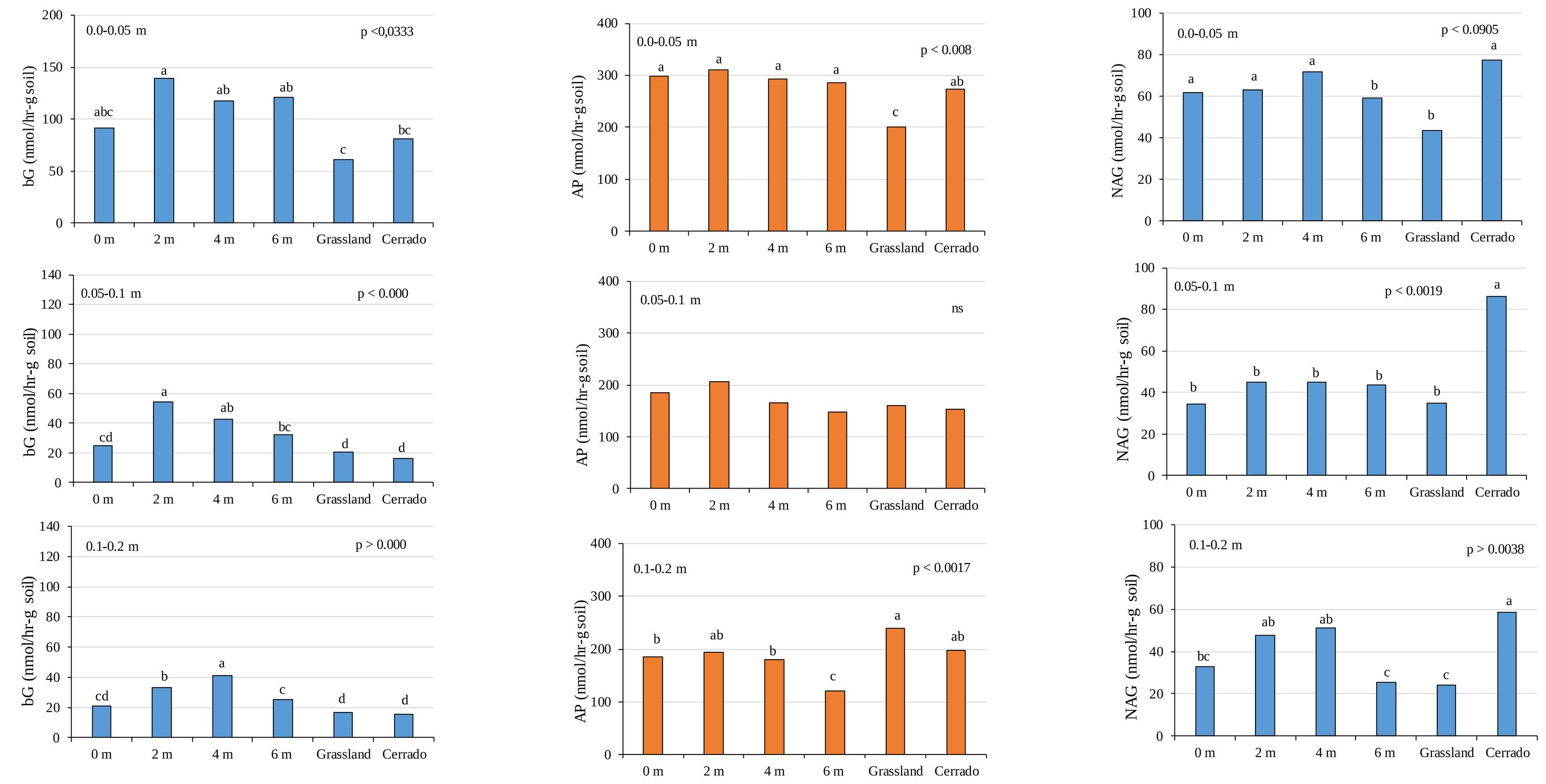

Figure 4. Soil extracellular enzyme activities in the integrated system, grassland, and native forest Cerrado. bG: β–glucosidase, C–requiring enzyme; AP: acid phosphatase, C & P–requiring enzyme, NAG: N–acetyl glucosidase, C & N–requiring enzyme

Results

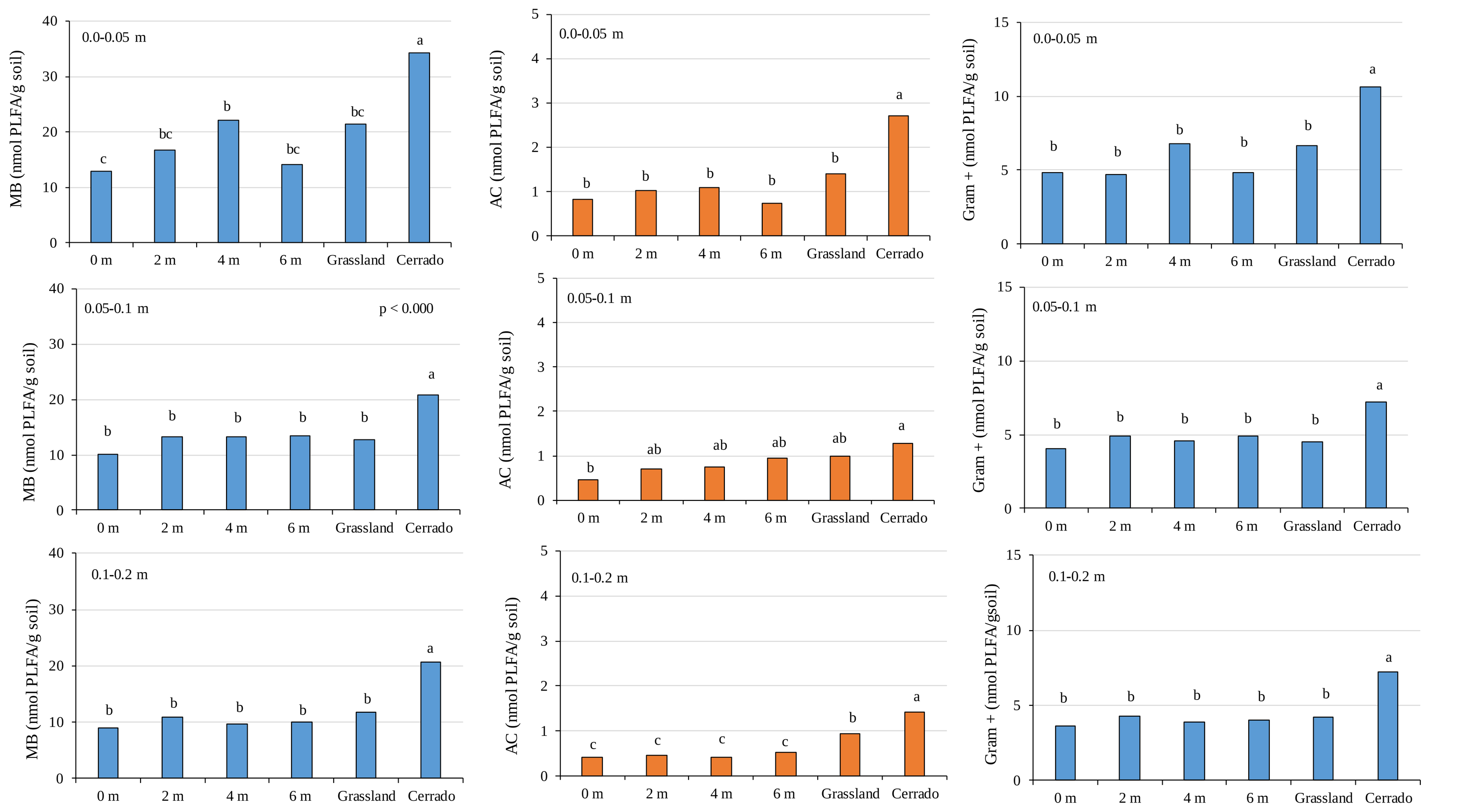

Figure 5. Soil microbial community compositions in integrated system, grassland and native forest Cerrado. MB: Microbial biomass; AC: Actinomycete: Gram +: gram–positive bacteria;

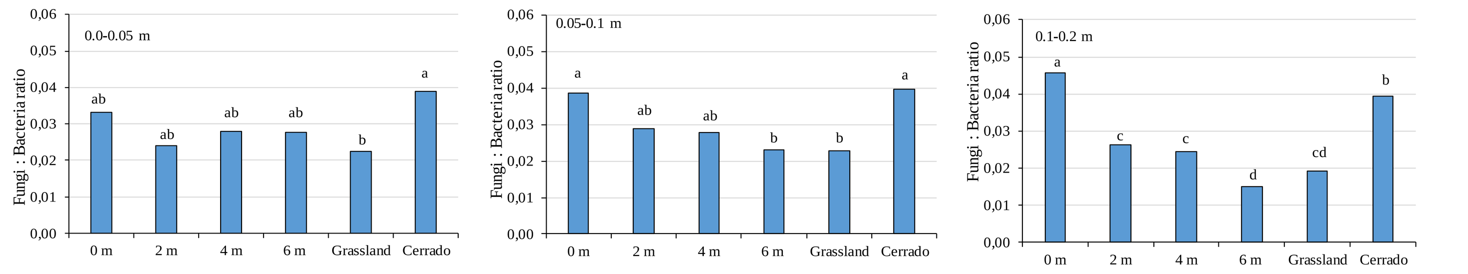

Figure 6. Soil Fungi:bacteria ratio in integrated system, grassland and native forest Cerrado. Fungi: AMF and Fungi; bacteria: Gram + and Gram -

Conclusions

Integrated crop-livestock systems show a stratification of soil moisture, with lower soil moisture near to the Eucalyptus.
Eight years after insertion of Eucalyptus into the pasture, in the eucalyptus (0 m) line and grassland presented SOC and TN similar to the native forest Cerrado, demonstrating the potential of the integrated system to elevate the COS and NT stocks.
Eucalyptus hybrid type did not affect SOC and TN, aggregate distribution, soil extracellular enzyme activities and microbial community.
The distribution of soil aggregates was similar in the Integrated crop-livestock systems, grassland and native area (Savanna).
The integrated production system with Eucalyptus trees enhanced the soil extracellular enzyme activities.
Soil microbial community was higher in native forest than in ICLS and grassland. After eight years, the Eucalyptus in the pasture did not affect soil microbial community.

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