C. Ciências Biológicas - 5. Ecologia - 1. Ecologia Aplicada

# SOIL RESPIRATION AS INDICATOR OF SOIL QUALITY IN SLASH-AND-BURN AND CHOP-AND-MULCH AGRICULTURAL SYSTEMS IN THE BRAZILIAN EASTERN AMAZONIA: RELATION WITH SELECTED SOIL PHYSICAL PROPERTIES.

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## INTRODUÇÃO:

The search for alternatives to fire in Amazon agriculture are urgently needed to prevent the loss of soil fertility and to reduce $CO_2$ release into the atmosphere (Denich et al., 2005). The challenge is to develop new practices which conserve soil and ecosystem's health and are economically attractive for farmers. The chop-and-mulch agriculture system is experimented since early 90's in eastern Amazonia. This system effectively protects soil fertility (Sommer et al., 2004) and provides better yields than the traditional slash-and-burn system (Parry and Vielhauer, 2000). However, little is known about the impact of chop-and-mulch on soil metabolism.

In search for indicators of soil quality in traditional and alternative agricultural practices, soil respiration was identified as a suitable indicator of soil metabolism. Indeed, $CO_2$ is produced about half by roots and associated mycorrhizae and half by microbial communities (Ryan and Law, 2005). However, soil respiration is greatly influenced by soil temperature and water content (Davidson et al., 2000), both related to soil physical properties.

This study compared soil respiration in two secondary forests with fields and pastures prepared with slash-and-burn or chop-and-mulch. The objective was to evaluate the potential of soil respiration to assess soil quality in relation to soil physical properties.

## METODOLOGIA:

The study was carried out in Igarapé-Açu, Bragantina region (PA, Brazil). The climate is equatorial humid with mean annual temperature of 25-27°C and annual precipitation between 1700 and 2700 mm. Soils are Kandiudults and original native vegetation is evergreen to semi-decidual tropical humid forest.

Six land-uses were evaluated for their impact on soil respiration: 1) 40 years secondary forest (F40y); 2) 20 y secondary forest (F20y); 3) slash-and-burn field (SB); 4) chop-and-mulch field (CM); 5) slash-and-burn prepared pastures (PSB); 6) chop-and-mulch prepared pastures (PCM).

Soil $CO_2$ efflux, soil temperature (T), and soil air relative humidity (RH) were measured once (3 measures per sample) during the rainy and dry seasons with an LI-6400 portable photosynthesis system and LI6400-09 soil flux chamber (LI-COR Inc. Lincoln, Nebraska). Bulk density (BD), field soil moisture (FSM), and water holding capacity (WHC) were determined gravimetrically; soil particle-size distribution was determined by the hygrometer method (Gee and Bauder, 1986).

Nested ANOVA (and SNK test) tested the effect of land use (n=6) and transects (n=3) on soil $CO_2$ efflux and physical variables (Underwood, 1997). Redundancy analysis (RDA) selected the significant soil physical variables that best explained $CO_2$ efflux (Legendre and Legendre, 1998).

**RESULTADOS:**

Only 3 variables were not significantly different among land-uses: RH (dry season), fine sand, and silt. Other 5 variables (T, RH in dry season, WHC, coarse sand, and clay) were significantly different among land uses but, did not explain a significant amount of soil respiration variation according to RDA. The BD and FSM (rainy and dry season) were significantly different among soil uses and were included in the RDA model. Soil T (rainy season) was also included in the model but explained a marginal fraction of soil respiration variation only (2%). All the variables were significantly different between the rainy and dry seasons, except T in SB and BD in pastures.

In the dry season, land-uses were divided in two distinct groups according to soil respiration : 1) forests; and 2) other uses. The rainy season showed 3 overlaying groups: 1) F20y, F40y, CM, SB; 2) F40y, CM, SB, PSB; and 3) CM, SB, PSB, PCM. The RDA model explained 31.7% of $CO_2$ efflux variation. The first axis (RDA 1 = 29.7%) represented a strong opposition between FSM (positively correlated with $CO_2$ efflux) and BD (negatively correlated with $CO_2$). The FSM was associated to forest sites and BD to PCM. Other soil uses were poorly separated along RDA 1 while CM was strongly (and positively) correlated with RDA 2, and therefore to T and FSM (rainy season).

**CONCLUSÕES:**

The secondary forests supported the highest respiration rates and the pastures the lowest, confirming the soil respiration ability to detect soil metabolism shift along a gradient of soil use intensification. Indeed, pasture is a permanent conversion of soil use, field crops are an intermediate system as it includes fallows, and secondary forests are the more natural ecosystems remaining in the Bragantina region. However, soil respiration was not able to detect differences between the slash-and-burn and chop-and-mulch systems probably because the SB site was at the end of its fallow period (4 y secondary forest) and the pastures were prepared 5 y ago, likely masking the positive effect of mulching on soil quality (mainly bulk density). The strong opposition between BD and FSM in the RDA model suggest that high BD limit water retention and is therefore the main factor limiting soil respiration in both seasons. The effect is stronger in the dry season where BD explained 23% of soil respiration. Soil respiration was confirmed as a suitable indicator of soil quality but more measurements should be considered to better characterize land-use effects on soil metabolism. Extensive old secondary forest cover is essential for soil conservation in regions with marked dry season and low native forest cover as the Bragantina region.

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Palavras-chave: Soil respiration, Soil physical properties, Land use

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