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SHORT –TERM EVOLUTION OF C-CO_2 EMISSIONS FOR A BRAZILIAN OXISOL: EFFECT OF TILLAGE AND RAINFALL

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Introduction

The soil organic carbon (SOC) content depends strongly on soil management and especially the level and quality of organic restitution to the soil. The SOC pool is the net result of carbon (C) input in the form of crop residue and biomass, and output including CO_2 flux and other losses (Duiker, 2000). Changes in soil management can alter SOC content. A substantial increase in the SOC content in the 10 cm topsoil layer in no-tillage soils compared with soils under natural vegetation and long-term conventional tillage (CT) (Séguy et al. 2003) can occur due to high crop-residue input and lack of soil disturbance.

Accounting for carbon (C) and nitrogen (N) dynamics in the active C and N pools is crucial to understand how management of production systems can be improved to sustain long term soil productivity especially in warm climates (Salinas Garcia, 97). In various studies, no-tillage seems to increase the SOC. However, this higher stock may generate higher emissions of CO_2.

We propose here some elements of a method that aims at following the main stages of the agricultural cycle and we present our first results.

Materials and methods

The experiment was carried out during the 2002-2003 cycle in Goiânia, Goiás, Brazil. The measures were conducted on a dark red latosol (pH = 5.9). The climate of the area is tropical with average annual temperature of 22.5 °C and total precipitation of 1500 mm. The experimental design consisted of 2 treatments (no tillage (NT) and conventional on Rice fields. Conventional system called here offset (OFF) consists in using a disk implement (0-15 cm depth) to prepare the soil before seeding.

•SOC measurements were realized with a CN analyser (LECO CN-2000, CENA- Piracicaba , Brazil).

•CO_2 emissions were monitored in two special circumstances: after plowing (offset disk, 10 to 15 cm depth) and after a strong rain using a manual system based on static chamber techniques and LI-COR 6262. This IRGA was connected to a closed chamber (volume = 6L/ surface = 0.08 m²) permitting exchanges between the chamber and the analyser. $[CO_2]_{chamber}$ were measured in a minimum of five discrete samples taken at regular intervals (1 minute) during the deployment period. The greater number and frequency of $[CO_2]_{chamber}$ measurements also facilitates using shorter deployment period in case you have an automatic analyser. CO_2 emissions from all the chambers were measured during 5-minutes periods in 6 replicates for each treatment.

Results

We first measured C stocks in this soil after 5 years of NT or OFF. As there was no significant difference in bulk density between the 2 systems (1.2 to 1.35 in 0-40 cm), we only considered the concentration of organic C in each soil (%C).

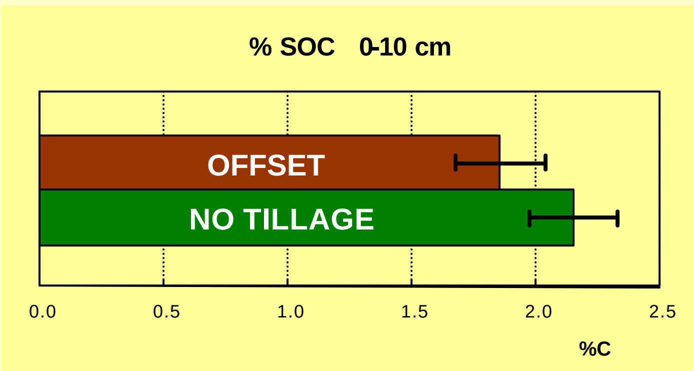

Figure 1: % carbon after 5 years of experimentation

We observe a non-significant increase in the SOC in NT systems compared to OFF. This increase was commonly observed under both temperate and tropical conditions (De Sá et al., 2001).

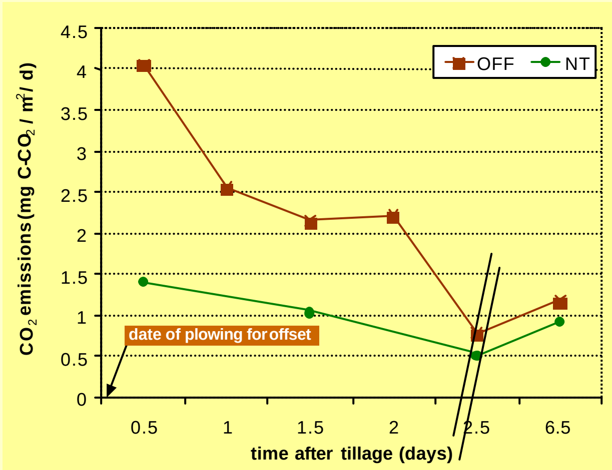

Figure 2: Effect of tillage on CO_2 emissions

NT systems: no change in CO_2 emission
OFF systems: strong increase in CO_2 emissions. (this increase tended to disappear 2.5 days after tillage)
Reicosky (1997) showed an important effect of tillage on the first day after

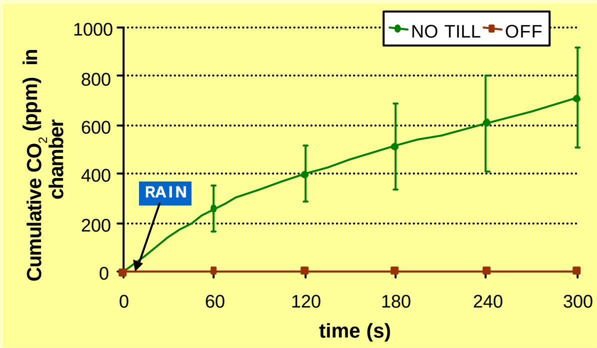

Figure 3: Effect of a strong rain (30 mm) on CO_2 emissions

OFF did not emit CO_2 at all, at least during the period following the rain

NT had a continuous and stable emission of CO_2.

The volumetric moisture was 46,9% and 46,5% for NT and OFF systems respectively

Discussion and conclusion

•differences of CO_2 emissions between the two cultivation techniques are due to physical, biological and chemical differences in the soil induced by the technique

•effect of tillage on CO_2 emissions: tillage breaks the aggregates which liberates the protected organic matter, then chemical consequences can be invoked such as the degradation by air of the aggregates

•effect of rain: the porosity in the 0-10 cm layer is different between tilled and no-tilled. We can explain the special consequence of tillage on CO_2 fluxes by the fact that most respiration activity occurs in the top 25 cm

•it is decisive to follow the CO_2 emissions all the cropping cycle long

•the impact of a technique is very complex for it may affect most physical, biological and chemical properties of a soil

The whole study (not presented here) will take into account this aspect and include measures of N_2O and CH_4 fluxes from soils as well as N mineral content, temperature, moisture, microbial biomass…

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