The effect of organic residues manipulation on soil DOC fluxes, microbial C, soil CO_2 efflux and soil C stocks in a tropical *Eucalyptus* plantation

Antoine Versini[1,2,3], Bernd Zeller[1], Jean-Paul Laclau[2] and Jacques Ranger[1]

[1]CIRAD, UMR 111, Functional Ecology & Biogeochemistry of soils & Agro-ecosystems, Montpellier, [2]INRA, UR 1138, Biogeochemistry of Forest Ecosystems, Champenoux; [3]Research Centre for the sustainability and the productivity of industrial plantations, Pointe Noire, Republic of Congo

Context and objectives

- **The tropical plantations, a major stake:** to reduce the pressure on tropical rainforests, to provide environmental services, to face the increasing demand in woody forest products (fuelwood, paper pulp)
- **The sustainability is threaten :** very poor sandy soils, fast-growing species**,** large amounts of nutrient exported within biomass at the end of each rotation (≈ 6-7 years)
- **The central role of organic matter** in tropical forests: fast-cycling of nutrients within the biological cycle, forest floor manipulations strongly affects tree growth over the rotation

*1/ Study the effect of organic manipulations on **DOC fluxes and composition** as well as on microbial C*

*2/ Determine whether organic residues removal or addition is likely to **modify the mineralization rate of the soil organic matter** (i.e. priming effect)*

3/ Assess the impact of organic residues management on C storage in the tropical soil of these plantations

Material & methods

At the harvest, the forest floor was either **removed** (**R**) or received **double amount of slash** (**DS**)

The stand were planted again and monitored during two years.

1/ **Soil solutions** were collected in both treatments and analysed for N and C contents, aromaticity (SUVA 254 nm) and $d^{13}C$.

- Zero tension lysimeter beneath the forest floor
- 15 cm
- 50 cm
- 1 m
- 2 m
- 3 m
- 4 m
- 6 m

Tension lysimeter and TDR trase

Water fluxes were estimated with the Hydrus 1D model calibrated from soil water content measurements.

1'/ **Microbial C** was measured by the extraction-fumigation method on soil samples at different dates.

2/ A complete **partitioning of soil CO_2 efflux** was performed for 3 treatment (R, control and DS) and 3 blocks in order to estimate the contribution of SOM to soil CO_2 effluxes

Measurement of total soil respiration with a LICOR 8100

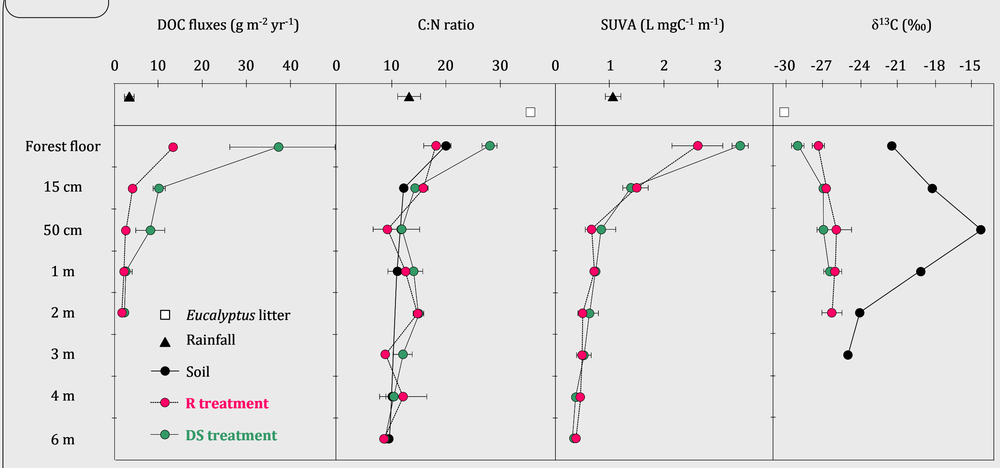
Contribution of the decomposing litter to heterotrophic respiration

Estimation of autotrophic respiration by upscaling specific root respiration rate with belowground biomass

3/ **Soil C balance** was deduced for each treatment after two years by subtracting the estimated SOM contributions to CO_2 efflux (see above) from C inputs from the litter (according to a microbial C use efficiency of 0.23).

Results & discussion

1 Effect of organic manipulations on DOC fluxes and composition



→ Large contribution of aboveground litter to the DOC production in the upper soil layer

→ Most of this DOC was either consumed by microorganisms or retained in the first 15cm

→ Decrease of the aromaticity (SUVA) with depth: adsorption > mineralization

→ Exchanges between the aqueous phase and SOM were low along the soil profiles ($\delta^{13}C$)

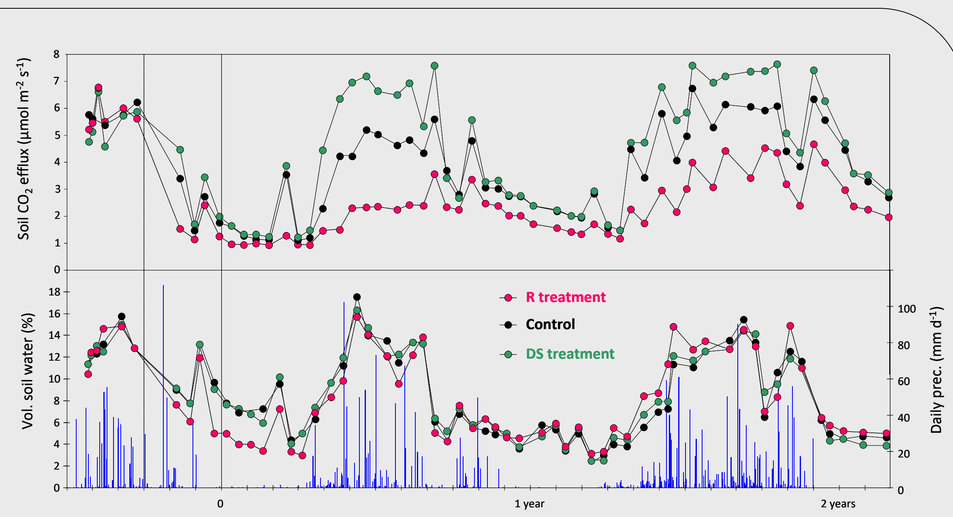
→ DOC losses were < 2.5 g m^{-2} yr^{-1} at a depth of 2 m despite the coarse soil texture: strong net adsorption of DOM on the high amounts of hydro(oxides) of Fe and Al

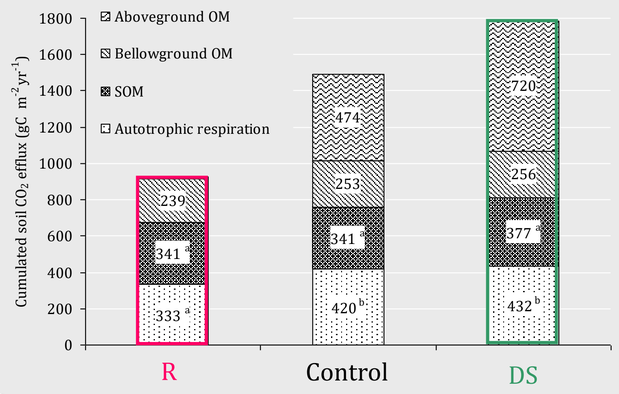
→ Consequences on C sequestration were limited since DOM fluxes were very low regarding the SOM stocks.

2 Soil CO_2 efflux

→ Soil moisture was little affected by organic manipulations because of early *Eucalyptus* root development

→ High effect of organic manipulations on soil CO_2 efflux during the rainy seasons





Partitioning of soil CO_2 efflux

→ Large contribution of aboveground OM to soil CO_2 efflux in the DS treatment

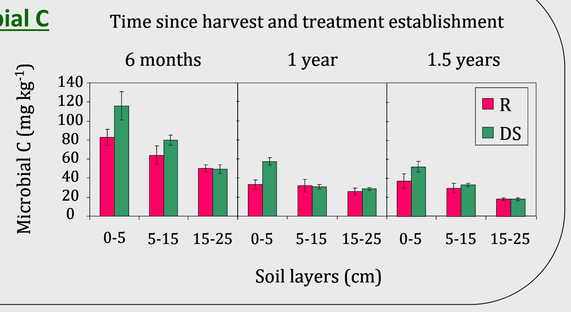
→ Higher autotrophic contribution in the DS treatment as a result of higher root biomass

→ The contribution of SOM was not significantly different between treatments

1' Effect of organic manipulations on microbial C

→ Microbial C highly increased after the harvest in both treatments

→ Microbial biomass was significantly higher in the DS treatment in the 0-5 cm soil layer



3 Soil C balance

→ C depletion after two years whatever the treatment

→ The decomposition of the remaining organic residues will counterbalance C depletion after one additional year in the control and DS treatments

	R	Control	DS
Soil C balance (kgC m^{-2} yr^{-1})	-0.52	-0.24	-0.16
C remaining in the forest floor (kgC m^{-2})	0	0.69 (+0.27)	1.19 (+0.37)

Conclusions

- Despite significant effects of organic residue manipulation on DOC fluxes and microbial biomass in the topsoil, the mineralization rates of SOM were not significantly affected.
- Organic residues contributes to maintain SOM stocks through successive rotations, ensuring the long-term productivity of these plantations. As a consequence, the retention of organic residues at the harvest should be optimized, burning of organic residues must be prohibited and wild fires prevented.

For further details, you can read "Versini A., Nouvellon Y., Laclau JP., Kinana A., Mareschal L., Zeller B., Ranger J. and Epron D., 2012. The manipulation of organic residues affects tree growth and heterotrophic CO_2 efflux in a tropical *Eucalyptus* plantation. *Forest Ecology and management* **in press**".

COST ACTION FPO803

Meeting Antalya, Turkey 2012