Effects of long term soil organic matter restitution mode on soil heterotrophic respiration and soil biological properties.

Pauline Buysse[1], Monique Carnol[2], Sandrine Malchair[2], Christian Roisin[3], Marc Aubinet[1].
[1]Unit of Biosystem Physics, University of Liege – Gembloux Agro-Bio Tech, Belgium;
[2]Plant and Microbial Ecology Laboratory, University of Liege, Belgium;
[3]Walloon Agricultural Research Centre, Gembloux, Belgium.

1. Introduction.

- Soil heterotrophic respiration (SHR) = important process to study given the possibility of a positive feedback to global change in the future.
- Agricultural soils are potentially large sources of CO_2, on which crop management has a considerable influence.

OBJECTIVES:

- Does long-term (> 50 years) application of different organic matter-restitution modes (OM-RM) cause differences in SHR fluxes?
- Do different OM-RM imply different responses of SHR to temperature and soil moisture content?

2. Material and Methods.

A. Study field:

- Situated in Liroux, near Gembloux.
- 6 different OM-RM (RM1 ➔ RM6) applied since 1959.
- 6 plots (repetitions) in each treatment: 10 by 70 (or 60) m.
- All plots ploughed over 0-25 cm depth.

B. Studied OM-RM:

- RM1: CONTROL (exportation of all crop residues).
- RM4: MANURE (input of manure every 3 to 4 years).
- RM6: RESTITUTION OF CROP RESIDUES (after each crop season).

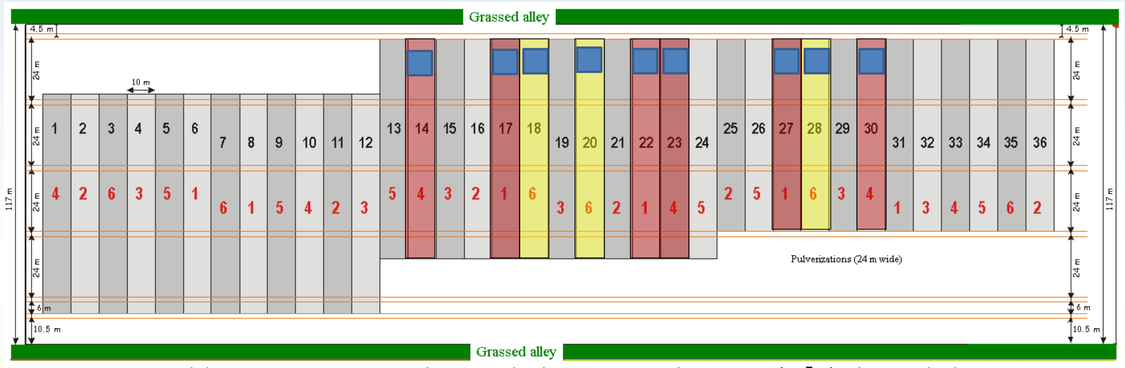

Fig.1: Experimental design at Liroux site. Numbers in red colour represent the OM-RM (1➔6). Plots studied in 2010 correspond to red and yellow rectangles, and those studied in 2011 correspond to red rectangles only. Blue squares represent the weeded areas.

C. Experimental design:

Soil CO_2 flux measurements in weeded areas (3 m by 3 m, blue squares in Fig.1) in 3 out of the 6 repetition plots. In 2011, we focused on the two most contrasted treatments, for which we increased the number of measurement points.

Table 1.

	Measurement campaigns	
Year	2010	2011
Measurement period	2 April – 30 July	5 May - onwards
Studied OM-RM	RM1, RM4, RM6	RM1, RM4
Number of measurement points/plot	4	6
Total number of points/treatment	12	18

D. Measurements.

- Soil CO_2 fluxes: Dynamic closed chamber system (Li-Cor Li-6400XT equipped with a 6400-09 Soil Chamber (Li-COR Biosciences Inc., US)).
- Soil temperature: 5 cm depth.
- Soil moisture content: 0-5 cm depth.

Fig. 2. Measurement system.

3. Results.

2010 — 2011 — Global results

A. Temporal evolution of soil CO_2 fluxes, temperature and moisture content.

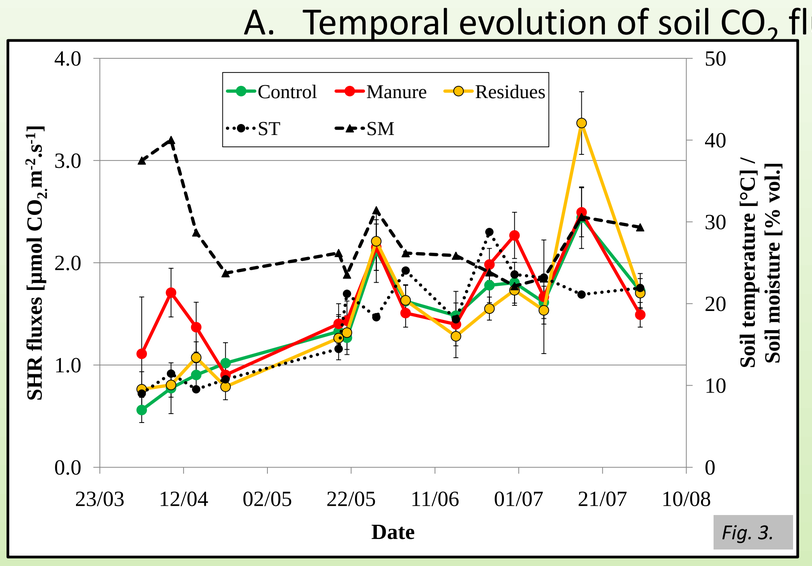

Fig. 3.

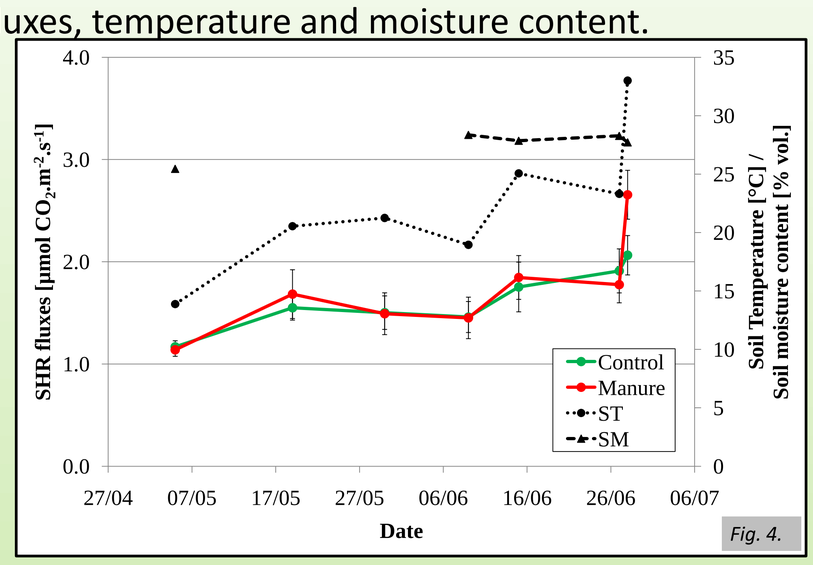

Fig. 4.

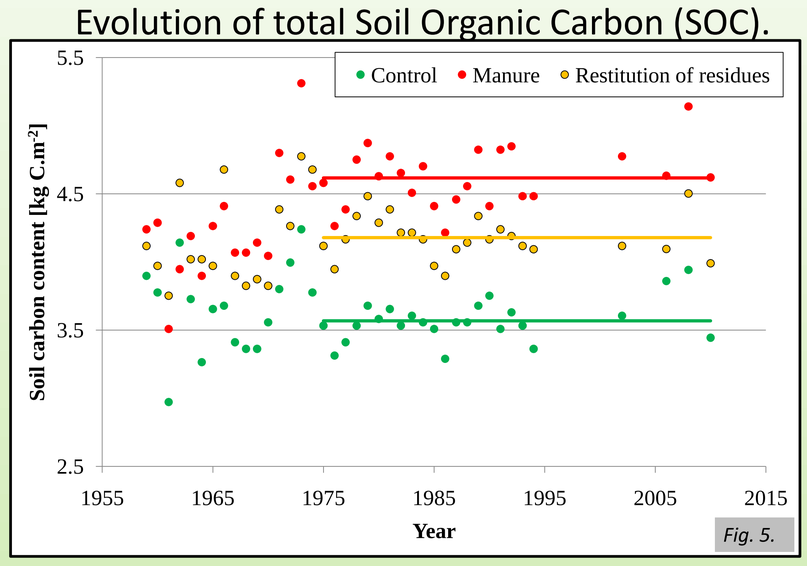

Fig. 5.

B. Soil CO_2 fluxes vs Soil temperature.

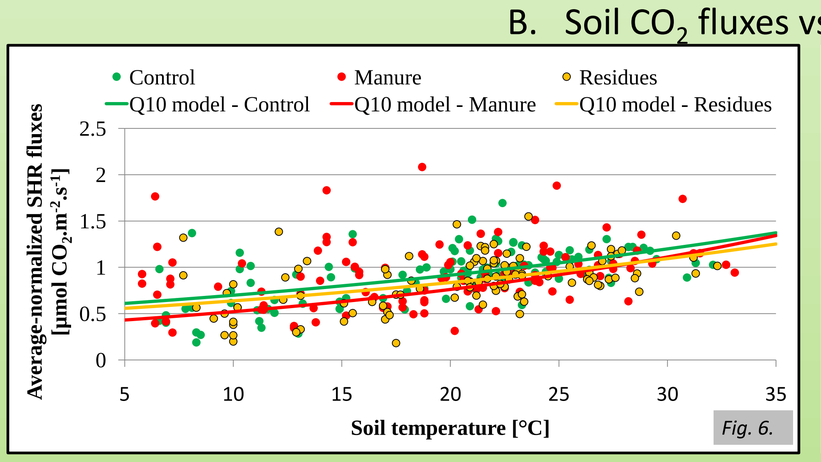

Fig. 6.

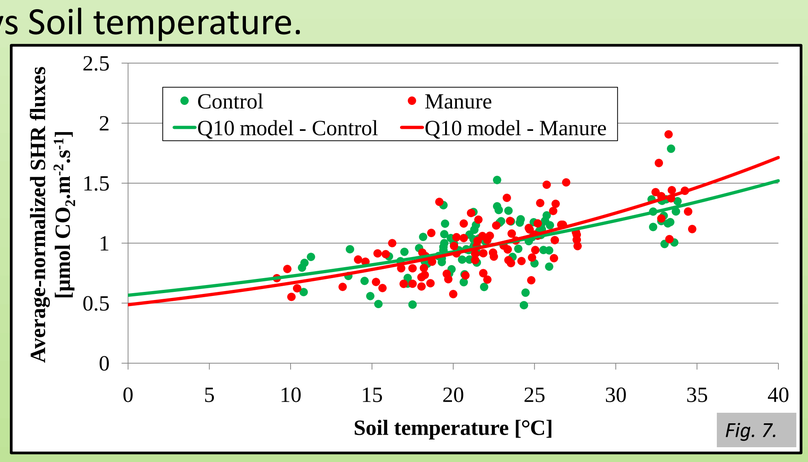

Fig. 7.

Table 2: Values of the parameters after application of the following equation ➔ $SHR\ flux = R_{15} * Q_{10}^{\frac{ST-15}{10}}$ *to the fluxes:*

	R_{15}		Q_{10}		R^2	
OM - RM	**2010**	**2011**	**2010**	**2011**	**2010**	**2011**
Control	0.8	0.82	1.31	1.28	0.32	0.37
Manure	0.63	0.78	1.46	1.37	0.15	0.51
Residues	0.73	-	1.31	-	0.24	-

C. Soil CO_2 fluxes vs Soil moisture content.

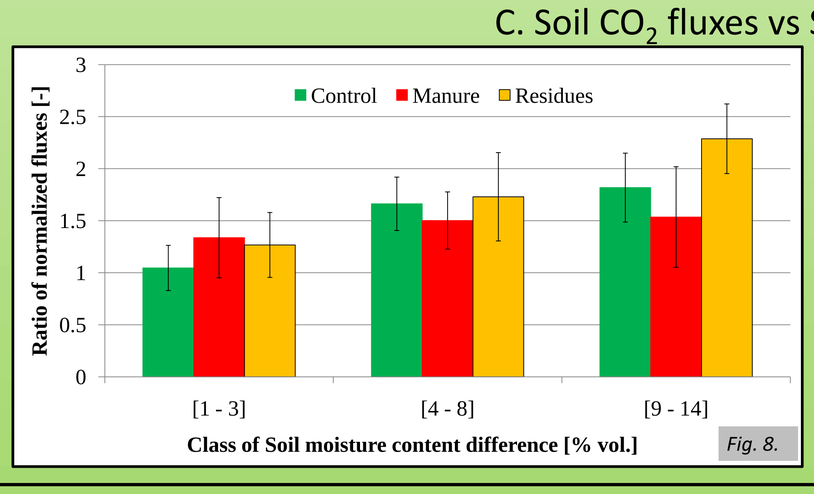

Fig. 8.

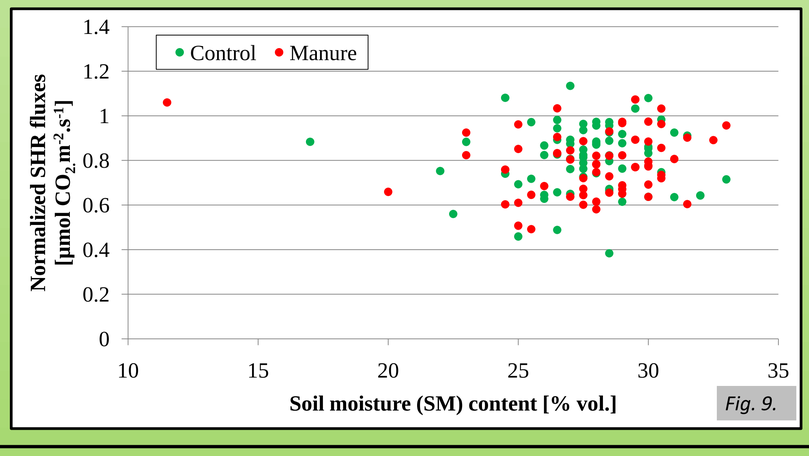

Fig. 9.

Comments:

- Large spatial variability ➔ The measured fluxes were divided by the average over the season for each collar (Fig. 6 and 7).
- Weak sensitivity to temperature (Table2).
- No significant difference regarding the response to temperature between treatments, both in 2010 and 2011 (Table 2, Fig. 6 and 7).
- But significant difference between treatments in terms of total soil organic carbon (Fig. 5).
- Impact of rain events in 2010: ratio of the fluxes of two consecutive dates significantly greater than 1 when SM increases; not as clear in 2011 (Fig. 8 and 9).

4. Discussion

- No differences appear between the treatments in terms of SHR fluxes.

➔ Potential reasons:

- ➢ Problem of spatial variability
- ➢ Both years, impact of drought ➔ low fluxes ➔ smaller differences, more difficult to put forward.

- Important response to rain events in 2010:
  - ➢ Possibly due to re-solubilization of labile carbon.

5. Perspectives

A. Soil microbial properties will be studied between treatments, for example:

- Basal respiration
- Labile C and N
- Metabolic profiles
- Microbial biomass

B. In the Manure treatment, soil CO_2 fluxes will be compared with and without fresh manure input.

Acknowledgements: This research is funded by the FRS-FNRS, Belgium

CONTACT PERSON: Pauline Buysse – FRS-FNRS Research fellow (Pauline.Buysse@ulg.ac.be)
Unit of Biosystem Physics, University of Liège – Gembloux Agro-Bio Tech, Belgium