Interannual variability of CO_2 fluxes and yield by a winter wheat crop (*Triticum aestivum* L.)

gembloux faculté universitaire des sciences agronomiques

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MAIN OBJECTIVES

Compare two growing seasons in order to identify impact of climatic conditions on :

- ❑ Carbon flows
- ❑ Plant growth
- ❑ Crop productivity

MATERIAL AND METHODS

1- Measurements

Net Ecosystem Exchange : Direct Eddy-Covariance measurement

Net Primary Productivity : Deduced from biomass measurements

Gross Primary Productivity : Inferred from Eddy covariance

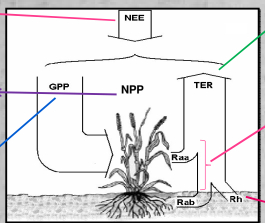

fig. 1: Carbon balance

Total Ecosystem Respiration : Inferred from Eddy-Covariance measurements

Autotrophic respiration (under and aboveground): By difference between TER and R_H

Heterotrophic respiration : Chamber measurements on root exclusion zones

2- Management and cultivars

On both seasons, the managements were similar and classic for winter wheat crop.

table 1 : Management and cultivar

	Season I (2004-2005)	Season II (2006-2007)
Previous crop	Sugar beet	Potato
Nitrogen fertilization :	201.5 kg N ha^{-1} 4 fractions	194.5 kg N ha^{-1} 3 fractions
Cultivar	Dekan	Rosario
Sowing	October 14th	October 13th
Harvest	August 2nd	August 5th

3- Climatic conditions

Differences between seasons :

- Milder winter with only 6 days with average temperature below 0°C on season II
- Drought in April and rainy conditions in June on season II
- Drought in May-June on season I

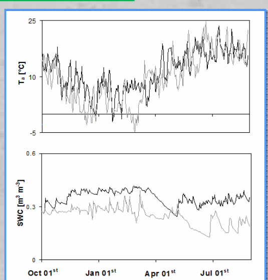

fig. 2: Climatic conditions (Ta : Air temperature, SWC : Soil Water Content)

CONCLUSION :

The impact on crop carbon balance of climate conditions was evaluated :

-Milder winter induced larger GPP and earlier development stages on season II.

-However, lower NPP and harvest were observed on season II.

-This was due to specific processes that appeared during flag leaf development and grain filling stage.

-This effect cannot be simulated by a simple flux to climate response model.

-This excess assimilated carbon was probably stored in the soil.

-This also suggests that GPP is not a good predictor of productivity.

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RESULTS

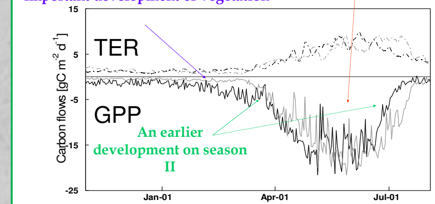

fig. 3 : Comparison of carbon fluxes on season I (Grey line) and season II (Dark line)

1- Carbon balance

table 2 : Carbon balance for two growing seasons

	Season I	Season II
NEE	-0.63 (0.03)	-0.73 (0.04)
GPP	-1.58 (0.13)	-1.68 (0.12)
TER	0.95 (0.13)	0.95 (0.12)
NPP	-0.88 (0.05)	-0.76 (0.05)

On season II, the crop had assimilated more carbon but productivity was lesser. Why ?

2- A greater carbon exchange on season II

Higher air temperature (Ta) and soil water content (SWC) on season II (fig 2) :

➔ **Higher GPP** during winter and spring (fig. 3)
➔ **Higher annual GPP** (fig. 3 and table 2)

3- Crop earliness

On season II, the earlier development was caused by **the milder winter** (fig. 2 and 3).

All stages were earlier, in agreement with GDD model :

Model : 1 leaf at 100 Growth Degree Day, tillering stage starts after 4 leaves (i.e. 400 GDD).

In practice : tillering started at 429 and 429 GDD respectively

4- TER and normalized respiration

- At the end of winter ,TER were similar (fig 3)
- However as temperature was larger on season II, TER should be larger.
- After temperature normalization :

TER season I > TER season II

Explanation : TER on season I was boosted by previous crop residues (table 3).

table 3: Previous crop residues and carbon

Previous crop	Sugar beet	Seed potato
End of vegetation	Sept. 29th	Aug. 6th
Harvest	Sept. 29th	Sept. 15th
Carbon	0.38 kg C m^{-2}	0.07 kg C m^{-2}

5- NPP and underground biomass

On season II : NEE = NPP at the end of tillering.
This is impossible because it would mean a zero heterotrophic respiration.
This could be explained by an underestimation of underground biomass.

6- Productivity

Lower productivity on Season II (table 4), despite a larger GPP, 3 causes :

Dry conditions in April (fig. 2) ➔ **Smaller flag leaf**
Humid and cloudy conditions during grain filling stage
➔ **lower assimilation** (fig .3)
➔ **disease development** (reduction of green LAI)

table 4: Productivity

	Season I	Season II
Yield - Grains (DM)	89.4 qx ha^{-1}	75.0 qx ha^{-1}
Yield - Straw (DM)	4.20 t ha^{-1}	3.38 t ha^{-1}
Grain density	75.5 kg hl^{-1}	69.9 kg hl^{-1}
Density	440 ears.m^{-2}	469ears.m^{-2}