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

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Main objectives

Compare two growing seasons on a winter wheat crop to identify impact of climatic conditions on:

- ❑ Carbon flows
- ❑ Plant growth
- ❑ Productivity

Material and method

1- Measurements :

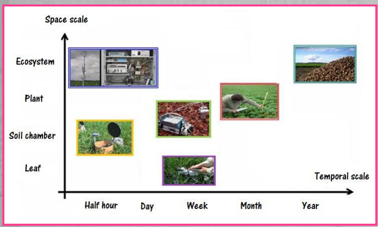

Fig. 1 : Different measurements

- ✓Climatic conditions
- ✓CO_2 fluxes
- ✓Dry Matter
- ✓Carbon contains
- ✓Growth stage
- ✓Leaf Area Index
- ✓Assimilation at leaf scale
- ✓Height
- ✓Density
- ✓Productuvity

2- Carbon balance

Net Ecosystem Exchange : Measured by Eddy-Covariance system

Gross Primary Productivity :
1) GPP = NEE-TER
2) Model with assimilation at leaf sacle

Net Primary Productivity :
1) $NPP = \sum (\%C_i * DM_i)$
2) $NPP = GPP + R_{AA} + R_{AB}$

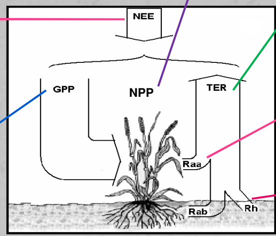

Fig. 2: Carbon balmance

Total Ecosystem Respiration : Measured by Eddy-Covariance system with night fluxes and extrapolated for day fluxes

Autotrophic respiration (under and aboveground)
$R_A = R_{AA} + R_{AB} = TER - R_H$

Heterotrophic respiration :
1) R_H = NEE-NPP
2) Mesured with soil chambers

3- Management and cultivars :

On season I and season II, the managements were similar and classic for winter wheat crop.

Table 1 : Managment and cultuvar

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

4- Climatic conditions

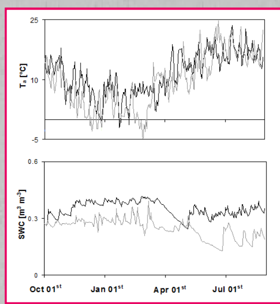

Fig. 3 : Climatic conditions

Particularities on season I

- In winter, 24 days with average temperature below 0°C (59 days with minimal temperature below 0°C).
- Drought in May-June

Particularities on season II

- Milder winter with only 6 days with average temperature below 0°C.
- Drought in April.
- Rainy and cloudy June.

Results

1- Carbon balance

Table 1 : 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)

Season II had assimilated more carbon but there was less stored carbon. Why ?

2- A greater carbon exchange on season II

On fig. 3 :
- Air temperature
- Soil Water Content

} Higher on season II than season I

However , 100 Growth Degree Day (GDD) = 1 leaf
Consequence : LAI and GPP were more important at the end of winter on season II (fig. 4 and table 1)

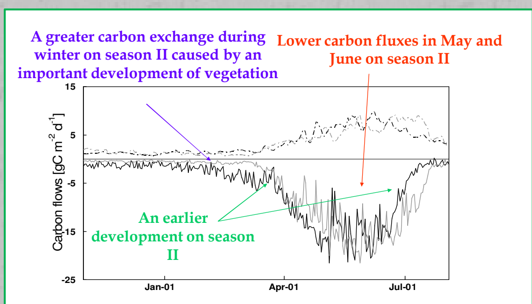

Fig. 4 : Comparison of carbon fluxes on season I(Grey line) and season II(Dark line)

3- Advance

100 GDD = 1 leaf
Tillering stage starts after 3-4 leaves

On season II, earlier development caused by milder winter wasobserved throughout growing season (fig. 4)

4- TER and Normalized respiration

At the and of winter ➔TER were similar (fig 4)
But after Temperature normalisation
➔ TER season I > TER season II

Exlpication : Previous crop (Table 2)

Table 2 : Previous crop and carbon

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

5- NPP and underground biomass

At the end of tillering on season II : NEE =NPP
But, it's impossible because R_H could not be null
Tillering stage ➔ Development plant and root system

We suppose that the underground biomass and %C were underestismated on season II.

6- Productivity

April conditions on season II (Fig. 3)➔ Small flag leaf
Bad conditions during filling grain (Fig .4)
Disease
➔ Bad productivity on season II (Table 3)

Table 3 : 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}
Ear density	440	469

CONCLUSION : This study allowed evaluating the impact of milder winter, drought period during stem elongation, and bad climatic conditions during filling grain stage on carbon balance, on crop development, roots system and eventually on yields.

It shows that GPP is not a good predictor of productivity.

Where did carbon go?

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