Farm-gate budget of energy crops: Green House Gases balance in a land use change from grassland to short rotation coppice of poplar

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General issue

FROM…

Crop rotation

LUC

…TO

Poplar SRC

Hp) DIFFERENCE IN GHGs (CO_2, CH_4, N_2O) EMISSION/ASSIMILATION

Case of study

Younger poplar SRC *(Y_SRC)*
Older poplar SRC *(O_SRC)*
Grassland *(GR)*

Objective

BALANCE OF GREEN-HOUSE GASES (GHGs)

CO_2 — N_2O, CH_4 — FARMING

EDDY COVARIANCE

SOIL CHAMBERS

FARMER

2012 – a special year

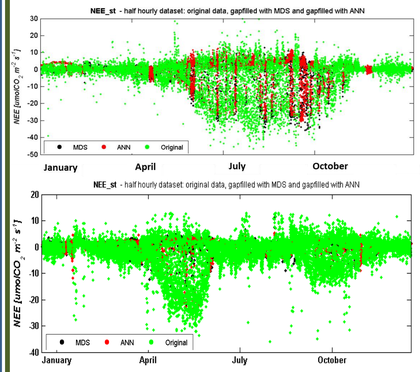

Fig. 1 – Comparison of half-hourly NEE fluxes in SRCs of poplar: common climatic conditions (Vigevano, top) and 2012, Viterbo (bottom)

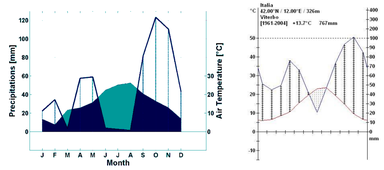

Fig. 2 – Ombrothermic diagrams: 2012 and long-term averages

Results

Eddy Covariance

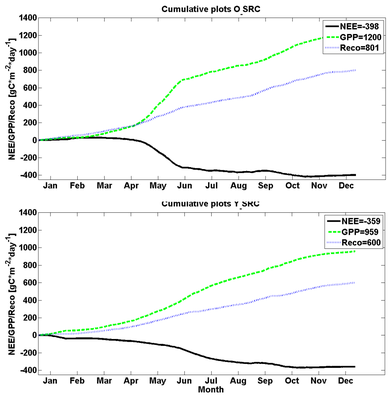

Fig. 3 – Cumulative graphs of NEE and components

	Y_SRC	O_SRC	GR
NEE ($gCm^{-2}y^{-1}$)	-359	-398	-218
GPP ($gCm^{-2}y^{-1}$)	959	1199	756
RECO ($gCm^{-2}y^{-1}$)	600	801	537

Tab. 1 – Cumulative C-fluxes (2012)

Absolute value of **NEE** in the SRCs was about **65-80% higher** than in the grassland, while the partitioning between **GPP** and R_{eco} shows that O_SRC had the higher rate of photosynthesis (25% higher than Y_SRC, and ca. 60% than grassland). Thus, $\mathbf{R_{eco}}$ was 33% higher in O_SRC than Y_SRC, and 40% than that grassland (**Fig. 3**, **Tab. 1**).

Soil chambers

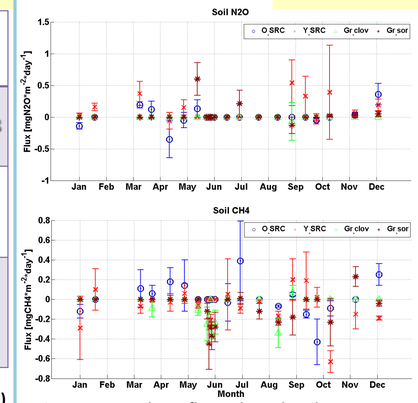

Fig. 4 – N2O and CH4 fluxes through soil

N_2O fluxes were extremely low, ranging from -0.6 to +1 mg $N_2O*m^{-2}*day^{-1}$. Also fluxes of **CH_4**, comprised between -1 and 0.8 mg $CH_4*m^{-2}*day^{-1}$ were low: the ecosystems acted sometimes as a little sink and sometimes as a small source. Any clear seasonal trend couldn't be observed for both the fluxes (**Fig. 4**).

Farming

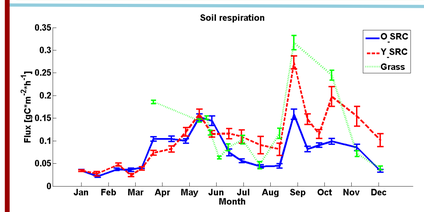

Fig. 5 – Soil Respiration in the three sites

When temperature was not limiting, **soil respiration** was driven by water content (**Fig. 5**): it can be noticed that during the summer drought fluxes of CO_2 from the soil reached low values (between 0.05 and 0.1 $gC*m^{-2}*day^{-1}$) close to the ones observed during the winter. At the rewetting a peak was measured: 0.15 - 0.32 $gC*m^{-2}*day^{-1}$.

Drought effects

Cumulative fluxes show a different response of the SRCs to the drought. We can analyse their behaviour in relation to water and light:

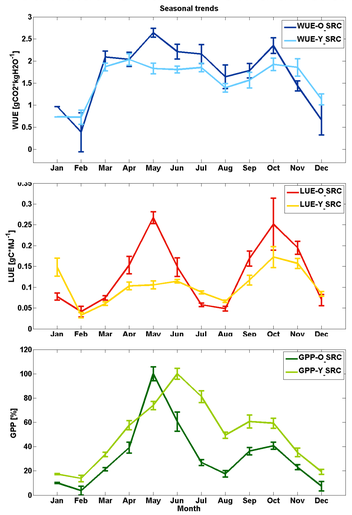

Fig. 6 – Monthly averages of WUE, LUE and GPP for the poplar SRCs

The **Water Use Efficiency (WUE)** was generally higher for O_SRC, especially in May (**Fig. 6, top**). During the summer drought, however, the reduction of WUE was less pronounced in the younger plantation than in the older one. **Light Use Efficiency (LUE)** also highlights a better yield of O_SRC in the spring, coupled with a stronger reduction during the drought(**Fig. 6, middle**). Trend of **Gross Primary Production (GPP)** shows that older short rotation coppice entered earlier in a stronger drought stress than the younger one (**Fig. 6, bottom**).

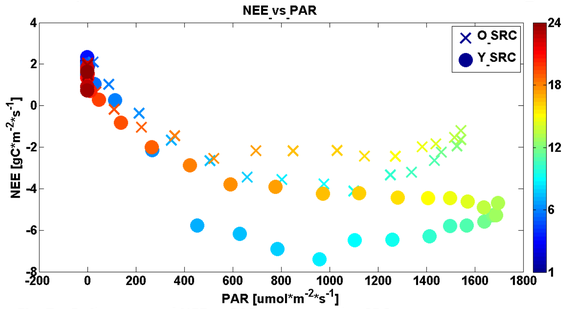

Fig. 7 – Daily means of NEE vs PAR for the poplar SRC

Comparison of daily averages of **NEE vs PAR** during the summer drought (**June-July**) confirms a higher C accumulation rate in the same conditions of light for the younger plantation (**Fig. 7**). Every point shows the average for the half hour indicated in the palette. Note the **hysteresis** with higher NEE during the afternoon – typical behaviour in drought events.

Conclusions

- **Higher uptake of CO_2 in the SRCs than in the grassland.**
- **Typical seasonal trend for soil respiration, while soil effluxes of CH_4 and N_2O were extremely low.**
- **Effects of prolonged summer drought: reduction in cumulative NEE trend; depression of soil respiration.**
- **Different behaviour of SRCs: higher efficiency in the spring for the older one; earlier drought stress.**
- **Data from 2013 important to understand the weight of the drought and to complete the GHG budget.**