

Introduction

Short rotation woody crops (SRWC), which usually consist of densely planted and high-yielding willow and poplar clones, can provide a sustainable source of energy. Furthermore, the potential of these systems as carbon sinks, recognized in the international debate on the global carbon balance and climate change impacts, may also make them a good option for many countries to receive 'carbon credits' to offset the effects of greenhouse gases emissions (Schulze et al. 2000).

With the purpose of evaluating and optimizing the contribution of this type of intensively managed crops in carbon sequestration, CO₂ vertical fluxes have been measured in a SRWC installed in Bragança, Portugal, within the framework of the research project Woody Biomass for Energy Production (PTDCAGR-CFL645002006).

This poster will focus on the description of the first steps towards the evaluation of the SRWC systems as carbon pools (Fig. 1).

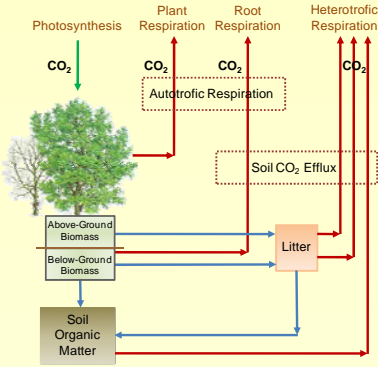


Figure 1: Schematic representation of the terrestrial ecosystems carbon cycle.

Study Area

SRWC were installed in 4 ha of a property managed by the ESAB-IPB. Crops were based on willow (*Salix* spp.), poplar (*Populus* spp.) and ash (*Fraxinus angustifolia*). These species were planted in a double row design at a density ranging from 15,000 to 20,000 cuttings per ha for willow and 10,000-15,000 cuttings per ha for poplar and ash (Fig. 2). Cuttings were 20-30 cm long and were obtained during the dormant season. Plantation took place before the Spring of 2007. In the following winter the plants were cut back to within 10cm of ground level to develop a coppice.

Soils are Chromic Luvisols (FAO/UNESCO, 1988) with a loam texture. In the 0-50 cm layer, organic carbon concentration vary from 4.5 to 7.6 g kg⁻¹, sum of exchangeable bases from 30 to 42 cmol_c kg⁻¹ and pH (H₂O) values are uniform (5,9-6,4).



Figure 2: Experimental design followed in SRWC trials. The red star indicates the location of the measuring system.

In this first stage of measurements, the CO₂ system was mounted in a poplar plot with the following characteristics: approximately between 1.5 - 2 m height and a global LAI of 1,2 m² m⁻².

Experimental Setup

Chamber based-techniques were designed to measure both CO₂ soil effluxes and exchange rates between the crops canopy and the atmosphere. Soil fluxes were measured by means of an open top dynamic chamber (Fang and Moncrief, 1998). Biosphere/atmosphere CO₂ exchange rates were evaluated by using a large ventilated ($\approx 0.5\text{m}^3\text{ s}^{-1}$) open top chamber (Ham et al., 1995). CO₂ concentrations were measured by using an ADC 2250 differential infrared gas analyzer coupled to an automatic gas sampling and a data acquisition/control system. Measurements were taken every 10 seconds and averaged over half hour intervals. To support our analysis, other relevant environmental variables such as meteorological, soil temperature, soil water content and soil water potential have also been monitored (Fig. 3).



Figure 3: Measuring system: (top side) large chamber for measuring plant canopy CO₂ exchange rates; (bottom left) CO₂ soil chamber; (bottom right) automatic sampling/acquisition system coupled with the ADC 2250.

Main Results

Meteorological Parameters

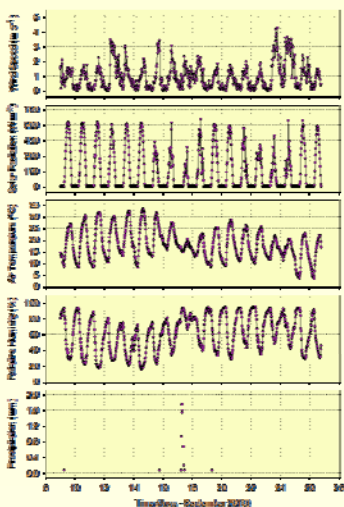


Figure 4: Meteorological variables, measured in the sampling site during September 2010.

Soil Conditions

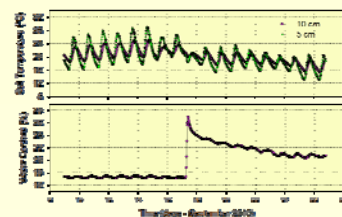


Figure 5: Soil conditions, measured in the sampling site during September 2010.

Operational Conditions

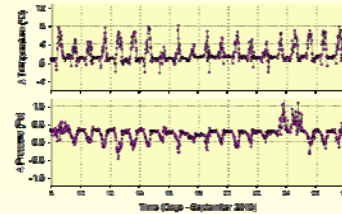


Figure 6: Operational conditions related to the large chamber, measured in the sampling site during September 2010. (Δ = inside conditions - outside conditions).

CO₂ Exchange Rates

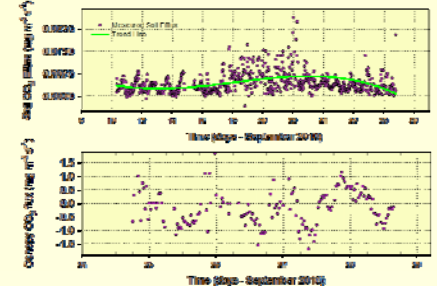


Figure 7: Soil CO₂ effluxes and canopy CO₂ exchange rates in a poplar plot, measured in the sampling site in September 2010.

- CO₂ exchange rates were evaluated along this startup phase under very extreme environmental conditions: very hot and dry conditions (Fig.4 and Fig. 5).
- According to our expectations, soil CO₂ effluxes were very low under these prevailing environmental conditions.
- The short time series of soil CO₂ efflux together with the associated trend line, depicted in the figure 7, show a positive correlation between precipitation and CO₂ emissions from soil, as has been reported in literature (Yue-Lin Li et al. 2008).
- Canopy CO₂ fluxes are now being measured as well, after a long period of continuous improvement of the system. Values show a predominant CO₂ uptake during daytime and an upward flux at night. However, values seem slightly overestimated, requiring further validation studies.

Final Remarks

- The startup of this study was marked by the prevalence of harsh environmental conditions which has influenced negatively the good functioning of the equipment.
- The results obtained so far are still scarce, but very encouraging since they show the ability of the system to obtain reliable measurements of CO₂ fluxes continuously.
- By the end of the current growing season the measuring system will be able to monitor soil and canopy CO₂ exchange rates over time and in several plots of the study area, in order to gather daily and seasonal patterns of net ecosystem CO₂ exchange rate.
- Additional improvements are required in order to validate and to assure more reliable CO₂ exchange rates such as including measurements of the surface energy balance terms.

References

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