WATER BALANCE AND WATER-USE EFFICIENCY OF A POPLAR BIO-ENERGY PLANTATION

Régis Fichot[1], Laura S. Broeckx[1], Melanie S. Verlinden[1], Gonzalo Berhongaray[1], Donatella Zona[1], Sophie Y. Dillen[1], John S. King[1,2], Kathy Steppe[3] & Reinhart Ceulemans[1]

1. Department of Biology, University of Antwerp, Research group of Plant and Vegetation Ecology (PLECO), Campus Drie Eiken, Universiteitsplein 1, B-2610 Wilrijk (Antw.), Belgium
2. Department of Forestry and Environmental Resources, North Carolina State University, Raleigh, NC 27695, USA
3. Department of Applied Ecology and Environmental Biology, University of Ghent, Laboratory of Plant Ecology, Coupure links 653, B-9000 Ghent, Belgium
e-mail: Regis.Fichot@ua.ac.be

Keywords: *Populus*, short-rotation coppice, up-scaling, water balance, water use efficiency

Among the different alternatives for fossil fuel substitution, the use of biomass crops is probably the most promising. Fast-growing trees grown under short rotation coppice (SRC) appear as attractive energy crops since they can be grown with quite reduced input costs and optimized land management. However, before conclusively considering SRC systems as ecologically and energetically relevant, it is necessary to ensure that benefits (mostly mitigation of CO_2 release and energy gain) outweigh potential costs. Noteworthy, the high productivity of such SRC systems is generally tightly associated to high rates of water consumption and, as a consequence, could alter local hydrological regimes and compete with irrigation for traditional land uses. The water balance of a typical SRC plantation and the efficiency with which water is used to produce a given amount of biomass must therefore be clearly assessed.

Here we present the framework and the first results related to the assessment of the water balance and the water-use efficiency of a poplar SRC system dedicated to the production of bioenergy. The field experiment was established on 7-10 April 2010 on a former farmland in Flanders (Belgium) and consists of a 18.4-ha high density plantation of 12 different poplar (*Populus*) hybrids and species maintained over a 2 + 2 years rotation scheme. Measurements of water use and carbon uptake are being and will be undertaken at different spatial (leaf, individual tree, ecosystem) and temporal (instantaneous, daily, seasonal) integration scales, using a combination of various techniques (leaf gas exchange measurements, use of stable isotopes, radial and height growth kinetics, sap flow monitoring, eddy fluxes). This will (*i*) provide a comprehensive understanding of the physiological and the environmental controls that act on water use and carbon uptake at each study scale, and (*ii*) allow the assessment of the water balance of the whole plantation. Information collected will also provide the data sets necessary to update, calibrate and validate process-based models to simulate the potential of poplar SRC cultures to mitigate CO_2 emissions in the not-too-distant future under conditions of global change.

This research is part of the POPFULL research project which aims at (*i*) providing a full accounting of the greenhouse gas balance, (*ii*) the quantification of energy efficiency and (*iii*) an analysis of the economic balance of a short rotation coppice (SRC) culture with poplar trees. It receives funding from the European Research Council under the European Community Seventh's Framework Programme (FP7 / 2007-2013), ERC grant agreement no. 233366 (POPFULL).