

ENVIRONMENTAL ASPECTS OF BIOMASS PRODUCTION: THE “POPLAR FREE AIR CO₂ ENRICHMENT (POPFACE)”* EXPERIMENT AS A MODEL TO STUDY THE IMPACT OF THE INCREASING CO₂ ON AGRO-FORESTRY SYSTEMS

Giuseppe Scarascia Mugnozza[†], Carlo Calfapietra, Maurizio Sabatti, Paolo De Angelis

The ecophysiological responses of trees and tree communities to global change, particularly in response to the predicted increase of atmospheric CO₂, will be crucial in determining the ability of woody plantations and natural forests to sequester carbon at the global scale. The few studies conducted at the whole-tree and community scale indicate that there will be a marked increase of primary production, but this increment will be mainly allocated into below-ground biomass. The present research combines a fast-growing, agro-forestry ecosystem, capable of elevated biomass production, with a large-scale FACE (free air CO₂ Enrichment) infrastructure (European FACE or EUROFACE), the only one available in the European Union in a forest tree stand.

The main objective of this experiment is to determine the functional responses of a cultivated multiclonal poplar plantation to actual and future atmospheric CO₂ concentrations, and to assess the interactive effects of this perturbation caused by human activities with the other natural environmental constraints on key biological processes and structures. Additionally, this project will yield relevant data to assess the potential for increasing the carbon sequestering capacity within the European Union, using such forest tree plantations. This project, therefore, combines the FACE technology with the study of mechanistic and process-based responses of a forest tree plantation, used as a model. Tree plantations represent a particular type of intensively managed ecosystem where the emphasis is placed on maximising biomass production over a relatively short time-scale.

The POPFACE experimental site was established near the city of Tuscania (Viterbo, Italy), on an agricultural field, 9 ha wide. The facility consisted of six circular experimental plots, each 314 m² wide. Three of these plots were treated at 550 ppm of CO₂ concentration, the forecasted concentration for the middle of this century, whereas the remaining plots were at ambient CO₂ concentration. The plantation was realized in spring 1999 utilising 30-cm long hardwood cuttings of three different poplar species, *Populus alba*, *P. nigra* and *P. x euramericana*; plant spacing is 1 x 1 m within the plots and 2 x 1 m in the remaining plantation, according to the principles of a high density, short rotation culture. The entire area was watered by drip irrigation throughout the project.

Above-ground woody biomass of trees exposed to elevated CO₂ for three growing seasons increased by 15 to 27%, depending on species. As a result, light-use efficiency increased. Above-ground biomass allocation was unaffected, and below-ground biomass also increased under elevated CO₂ conditions, by 22 to 38%. *Populus nigra*, with total biomass equal to 62.02 and 72.03 Mg ha⁻¹ in ambient and elevated CO₂, respectively, was the most productive species, although its productivity was stimulated least by atmospheric CO₂ enrichment. There was greater depletion of inorganic nitrogen from the soil after three growing seasons in elevated CO₂, but no effect of CO₂ on stem wood density, which differed significantly only among species.

The present study contributes to clarification of the implications of carbon allocation for long-term carbon storage on agro-forestry systems.

Keywords: poplars, short-rotation-forestry, agro-forestry, global change, Carbon sequestration, FACE facility

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[†] Institute for Agroenvironmental & Forest Biology - CNR – Villa Paolina, 05010 Porano (TR), Italy. E-mail: giuseppe.scarascia@ibaf.cnr.it