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Potassium nutrition and water availability affect phloem transport of photosynthetic carbon in eucalypt trees

Daniel Epron (1,2,3), Osvaldo Cabral (4), Jean-Paul Laclau (3,5), Masako Dannoura (6), Ana Paula Packer (4), Caroline Plain (1,2), Patricia Battie-Laclau (5), Marcelo Moreira (5), Paulo Trivelin (5), Jean-Pierre Bouillet (3,5), Dominique Gérant (1,2), Yann Nouvellon (3,5)

(1) Université de Lorraine, Nancy, France, (2) INRA, Nancy, France, (3) CIRAD, Montpellier, France, (4) Embrapa Meio Ambiente, Jaguariuna, Brazil, (5) Universidate de Sao Paulo, Piracicaba, Brazil, (6) University of Kyoto, Kyoto, Japan

Potassium fertilisation strongly affects growth and carbon partitioning of eucalypt on tropical soil that are strongly weathered. In addition, potassium fertilization could be of great interest in mitigating the adverse consequences of drought in planted forests, as foliar K concentrations influence osmotic adjustment, stomatal regulation and phloem loading. Phloem is the main pathway for transferring photosynthate from source leaves to sink organs, thus controlling growth partitioning among the different tree compartments. But little is known about the effect of potassium nutrition on phloem transport of photosynthetic carbon and on the interaction between K nutrition and water availability.

In situ 13C pulse labelling was conducted on tropical eucalypt trees (Eucalyptus grandis L.) grown in a trial plantation with plots in which 37% of throughfall were excluded (about 500 mm/yr) using home-made transparent gutters (-W) or not (+W) and plots that received 0.45 mol K m-2 applied as KCl three months after planting (+K) or not (-K). Three trees were labelled in each of the four treatments (+K+W, +K-W, -K+W and –K-W). Trees were labelled for one hour by injecting pure $13CO_2$ in a 27 m3 whole crown chamber.

We estimated the velocity of carbon transfer in the trunk by comparing time lags between the uptake of $13CO_2$ and its recovery in trunk CO_2 efflux recorded by off axis integrated cavity output spectroscopy (Los Gatos Research) in two chambers per tree, one just under the crown and one at the base of the trunk. We analyzed the dynamics of the label recovered in the foliage and in the phloem sap by analysing carbon isotope composition of bulk leaf organic matter and phloem extracts using an isotope ratio mass spectrometer.

The velocity of carbon transfer in the trunk and the initial rate 13C disappearance from the foliage were much higher in +K trees than in –K trees with no significant effect of rainfall. The volumetric flow of phloem, roughly estimated by multiplying the velocity of C transfer with the bark cross-section area of tree at 1.30m high, was also higher in +K trees than in –K trees and well-correlated with crown photosynthesis and with the xylem sapflow density.