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Carbon sources of voc biosynthesis in poplar

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Poplar trees produce and emit a large variety of biogenic volatile organic compounds (BVOC), such as aldehydes, isoprene, alcohols and esters in a temperature- and light-dependent manner ([1]). The biosynthesis of isoprene, the quantitatively most important BVOC, is located in the chloroplasts, and it is closely related to photosynthesis: feeding plants with $^{13}CO_2$ shows a fast labelling of isoprene ([2]). However, the proportion of labelled isoprene decreases under stress conditions ([3]), indicating that also other carbon sources are used for isoprene biosynthesis ([4,5]).

In the present work stable isotope labelling with $^{13}CO_2$and ^{13}C-Glucose [U-^{13}C6] was carried out on one-year old poplar saplings. Carbon fluxes within the plant and into various plant volatiles were monitored in relation to photosynthetic gas exchange. In particular, we studied (i) the different carbon sources of isoprene biosynthesis, (ii) calculated their contribution to isoprene emission, (iii) analyzed and measured the carbon fluxes of isoprenoid intermediates between cytosol and chloroplasts, and (iv) measured the distribution of labelled carbon along the whole plant (roots, stem, leaves, shoot) with regard to isoprene and other BVOC emission under non-stress and stress conditions in isoprene-emitting wild-type and transgenic non-emitting poplars.

For the experiments two dynamic cuvettes were run in parallel on one plant to detect exchange of ^{13}C between leaves at different levels (source/sink leaves). The label was applied in two different ways: in intact plants $^{13}CO_2$ was fed to a fully mature source leaf, while in plants with their roots cut off ^{13}C-Glucose was supplied to the transpiration stream via the xylem. The $^{13}C/^{12}C$ ratio in CO_2 exchanged between the leaves and the cuvettes air was monitored with a tunable diode laser absorption spectrometer (TGA100A, Campbell Scientific), whereas online quantification of la-

belled/unlabelled isoprene and other BVOC emitted by the leaves was achieved by PTR-MS. In addition, FLASH EA-IRMS was used to measure TOC (total organic carbon) and $^{13}C/^{12}C$ ratio of the different plant parts.

The data clearly show an incorporation of ^{13}C-label in the BVOC emitted after feeding either $^{13}CO_2$ to a mature "source" leaf or ^{13}C-Glu to the xylem of branch cuttings. Depending on the carbon source ($^{13}CO_2$ or ^{13}C-Glu) different proportions of isoprene were labelled. However, emissions of labelled carbon compounds (CO_2, isoprene and other BVOC) were only detected in the labelled source leaf within the measurement period, but not in any of the younger leaves after labelling with $^{13}CO_2$. In contrast, labelling with ^{13}C-Glu resulted in ^{13}C-labelled emissions from all sampled leaves. During and after feeding of $^{13}CO_2$ to a source leaf, labelled sugar was accumulated in the solution of branch cuttings. Similarly, in experiments that included measurements of root respiration, root respiration became increasingly ^{13}C-labelled.

References:

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