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14C assimilate allocation to rhizosphere compartments

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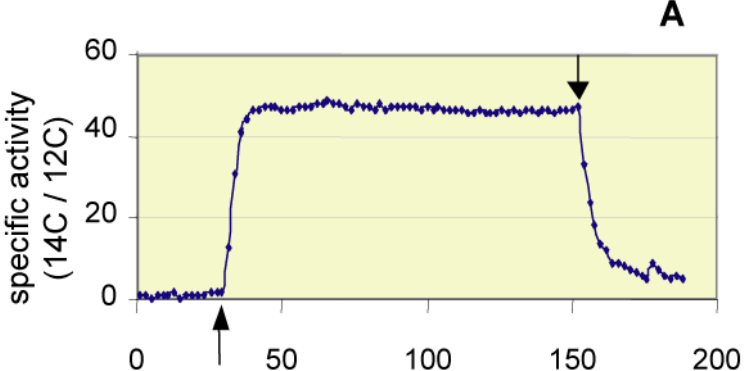
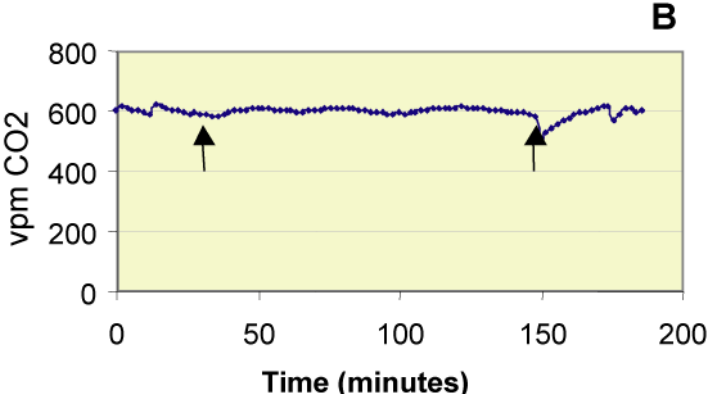
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3.2. Element Cycling and Organic Matter Turnover

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<i>Parameter</i>	¹⁴C assimilate allocation to rhizosphere compartments
<i>Soil type</i>	All kinds
<i>Plant species</i>	Various cultivated species including maize, ryegrass, <i>Medicago</i> sp.
<i>System</i>	field soil or artificially manipulated, in microcosms of different size
<i>Method</i>	¹⁴C-labelling of plant shoots, ¹²C-CO₂ and ¹⁴C-CO₂ monitoring
<i>Method description</i>	<p>Labelling of photoassimilates with isotopes (¹³C or ¹⁴C) is a useful method that allows to distinguish root-released C from C coming from soil organic matter. Conventional uses of the method lead to plant disturbance; no or poor regulation of CO₂ concentration of the atmosphere can affect photosynthesis and partitioning of C in the plant and rhizosphere compartments.</p> <p>Prior to labelling, shoots are separated from the belowground compartment (see 32_Warembourg_c). C-CO₂ and ¹⁴C specific activity of the atmosphere in the labelling chamber are regulated with a β radiations scintillation detector (equipped with a plastic cell for gas) coupled with an infrared gas analyser. Other climatic parameters of the labelling chamber are regulated that allow to study net CO₂ assimilation and C partitioning in the plant-soil-microorganisms with minimized plant disturbances. The method is relevant for pulse and long term labelling of plant shoots.</p>
<i>Do's, don'ts, potential limitations, untested possibilities</i>	<p>The ¹⁴CO₂ is distributed either from a gas cylinder or generated by addition of NaH¹⁴CO₃ solution available commercially in 1 M lactic acid. The specific activity of the atmosphere is determined according to the following parameters: duration of labelling, number of plants within the chamber, activity to be detected in the lowest labelled compartment (usually ¹⁴C incorporated in the microbial biomass). During all the experiment, total CO₂ in the chamber is regulated at a constant concentration (see example given Fig. 1) by mass flow controllers. The most difficult aspect is to reach the required specific activity as soon as possible after the beginning of the labelling. This is achieved in 10 min. by injection at t=0 of a sufficient amount of ¹⁴CO₂ in the chamber (calculated according to the volume of the chamber and the required CO₂ concentration). The release of ¹⁴CO₂ is faster with lactic acid than with sulfuric acid. Then, regulations occurred according to the plant uptake. Plant shoots can be exposed to ¹⁴CO₂ either for short periods (minutes to hours) or longer ones (1 to many photoperiods). The belowground compartment is continuously flushed with air without CO₂, and CO₂ coming from the rhizosphere respiration is trapped in 1M NaOH (see 32_Warembourg_c).</p> <p>All data are recorded on computers and net CO₂ assimilation by plants can be calculated. Immediately after labelling and for the chase period, air from the chamber is forced to pass through a soda lime trap in order to decrease the ¹⁴C activity in the chamber, while ¹²CO₂ is continuously injected in the chamber to compensate trapping and plant uptake. After the chase period, plant and soil compartments are sampled and ¹⁴C and total C analysed (shoots, roots, adhering soil, bulk soil, microbial biomass, rhizosphere</p>

	<p>respiration).</p> <p>A part of the ^{14}C respired by the shoots during the chase period can be re-fixed during the chase period. To avoid this problem, the chamber has to be continuously flushed with renewed air or the ^{14}C continuously trapped in soda lime cartridge. The volume of the chamber has to be adapted to the plant size. Regulations and data acquisition are achieved by a software written in Visual basic. The same device can be used with $^{13}\text{CO}_2$ and has already been used for ^{15}N labelling of plant shoots with $^{15}\text{N-NH}_3$ (study of N rhizodeposition).</p>
References	<p>Recent papers where this methodology has been used and briefly described : Bazot, S., Ulf, L., Blum, H., Nguyen, C., Robin, C. 2005. Effects of elevated CO_2 concentration on rhizodeposition from <i>Lolium perenne</i> grown on soil exposed to 9 years of CO_2 enrichment. Soil Biology Biochemistry, in press</p> <p>Henry, F.; Nguyen, C.; Paterson, E.; Robin, C. 2005. How does N availability alter rhizodeposition in <i>Lolium multiflorum</i> Lam. during vegetative growth? Plant and Soil, 269: 181-191.</p> <p>Related paper describing generation of $^{14}\text{CO}_2$: Nguyen, C.; Todorovic, C.; Robin, C.; Christophe, A.; Guckert, A 1999. Continuous monitoring of rhizosphere respiration after labelling of plant shoots by $^{14}\text{CO}_2$. Plant and Soil, 212: 191-201.</p>
Links	<p>Site of the laboratory with pictures on the methodology: http://www.ensaia.inpl-nancy.fr/lae/</p>
Additional information:	<p>Fig. 1. Pulse labelling of plant shoots with $^{14}\text{CO}_2$, aiming to determine C partitioning in the plant and the rhizosphere compartment. In this example, ryegrass plants were labelled in an atmosphere enriched with CO_2 ($600 \mu\text{L L}^{-1}$) at a constant specific activity.</p> <p>A : kinetics of the specific activity of the atmosphere fixed at $50 \text{ KBq mg}^{-1} \text{ C}$ during labelling.</p> <p>B : kinetics of the CO_2 concentration in the chamber. The duration of labelling was 120 min. and the mean CO_2 concentration during labelling was $598 \pm 7.5 \text{ vpm}$. Arrows represent the beginning and the end of the labelling period. ^{14}C is detected with a scintillation detector Radiomatic A500 TR Packard Instruments (one acquisition every two min.) and CO_2 detected with an IRGA ADC</p> <div style="display: flex; justify-content: space-around;">   </div>