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## 14C assimilate allocation to rhizosphere compartments

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<i>Parameter</i>	<b><sup>14</sup>C assimilate allocation to rhizosphere compartments</b>
<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>	<b><sup>14</sup>C-labelling of plant shoots, <sup>12</sup>C-CO<sub>2</sub> and <sup>14</sup>C-CO<sub>2</sub> monitoring</b>
<i>Method description</i>	<p>Labelling of photoassimilates with isotopes (<sup>13</sup>C or <sup>14</sup>C) 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 CO<sub>2</sub> 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 <b>32_Warembourg_c</b>). C-CO<sub>2</sub> and <sup>14</sup>C 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 CO<sub>2</sub> 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 <sup>14</sup>CO<sub>2</sub> is distributed either from a gas cylinder or generated by addition of NaH<sup>14</sup>CO<sub>3</sub> 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 <sup>14</sup>C incorporated in the microbial biomass). During all the experiment, total CO<sub>2</sub> 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 <sup>14</sup>CO<sub>2</sub> in the chamber (calculated according to the volume of the chamber and the required CO<sub>2</sub> concentration). The release of <sup>14</sup>CO<sub>2</sub> is faster with lactic acid than with sulfuric acid. Then, regulations occurred according to the plant uptake. Plant shoots can be exposed to <sup>14</sup>CO<sub>2</sub> either for short periods (minutes to hours) or longer ones (1 to many photoperiods). The belowground compartment is continuously flushed with air without CO<sub>2</sub>, and CO<sub>2</sub> coming from the rhizosphere respiration is trapped in 1M NaOH (see <b>32_Warembourg_c</b>).</p> <p>All data are recorded on computers and net CO<sub>2</sub> 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 <sup>14</sup>C activity in the chamber, while <sup>12</sup>CO<sub>2</sub> is continuously injected in the chamber to compensate trapping and plant uptake. After the chase period, plant and soil compartments are sampled and <sup>14</sup>C and total C analysed (shoots, roots, adhering soil, bulk soil, microbial biomass, rhizosphere</p>

	<p>respiration).</p> <p>A part of the <math>^{14}\text{C}</math> 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 <math>^{14}\text{C}</math> 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 <math>^{13}\text{CO}_2</math> and has already been used for <math>^{15}\text{N}</math> labelling of plant shoots with <math>^{15}\text{N-NH}_3</math> (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 <math>\text{CO}_2</math> concentration on rhizodeposition from <i>Lolium perenne</i> grown on soil exposed to 9 years of <math>\text{CO}_2</math> enrichment. <i>Soil Biology Biochemistry</i>, 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? <i>Plant and Soil</i>, 269: 181-191.</p> <p>Related paper describing generation of <math>^{14}\text{CO}_2</math> :  Nguyen, C.; Todorovic, C.; Robin, C.; Christophe, A.; Guckert, A 1999. Continuous monitoring of rhizosphere respiration after labelling of plant shoots by <math>^{14}\text{CO}_2</math>. <i>Plant and Soil</i>, 212: 191-201.</p>
Links	<p>Site of the laboratory with pictures on the methodology:  <a href="http://www.ensaia.inpl-nancy.fr/lae/">http://www.ensaia.inpl-nancy.fr/lae/</a></p>
Additional information:	<p>Fig. 1. Pulse labelling of plant shoots with <math>^{14}\text{CO}_2</math>, aiming to determine C partitioning in the plant and the rhizosphere compartment. In this example, ryegrass plants were labelled in an atmosphere enriched with <math>\text{CO}_2</math> (<math>600 \mu\text{L L}^{-1}</math>) at a constant specific activity.</p> <p><b>A</b> : kinetics of the specific activity of the atmosphere fixed at <math>50 \text{ KBq mg}^{-1} \text{ C}</math> during labelling.</p> <p><b>B</b> : kinetics of the <math>\text{CO}_2</math> concentration in the chamber. The duration of labelling was 120 min. and the mean <math>\text{CO}_2</math> concentration during labelling was <math>598 \pm 7.5 \text{ vpm}</math>. Arrows represent the beginning and the end of the labelling period. <math>^{14}\text{C}</math> is detected with a scintillation detector Radiomatic A500 TR Packard Instruments (one acquisition every two min.) and <math>\text{CO}_2</math> detected with an IRGA ADC</p> <div style="display: flex; justify-content: space-around;"> <div data-bbox="630 1003 1380 1422"> </div> <div data-bbox="630 1422 1380 1895"> </div> </div>