Application of carbon isotopes in photosynthetic research

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There are two naturally occurring stable isotopes of carbon, ^{12}C and ^{13}C. Most of the carbon is ^{l2}C (98.9%), with l.1% being ^{l3}C. It has been known for decades that the stable carbon isotope ratios ($^{13}C/^{12}C$) of the organic matter of terrestrial plants vary amongst plants species and with environment. These variations can be explained by carbon isotope fractionations occurring during photosynthetic CO_2 fixation which are caused by fractionations occurring during diffusion of CO_2 and during enzymatic carboxylation reactions [1, 2]. Discrimination during photosynthesis has a significant effect on isotope composition of atmospheric CO_2 at the regional and global levels which are relevant to studies of the global carbon cycle.

New optical isotope analysers (lasers and Fourier transform infrared spectroscopy) now allow for rapid measurement of carbon isotope ratios in air which allows us to combine conventional measurements of leaf CO_2 uptake with measurements of carbon isotope discrimination to probe photosynthetic mechanisms [3]. This is being used to provide better mechanistic understanding of photosynthetic processes and as a breeding tool for crop improvement.

[1] Farquhar, G.D., M.H. O'Leary, and J.A. Berry, *On the relationship between carbon isotope discrimination and the intercellular carbon-dioxide concentration in leaves.* Australian Journal of Plant Physiology, 1982. **9**: p. 121-137.

[2] O'Leary, M.H., *Carbon isotope fractionations in plants* Phytochemistry, 1981. **20**: p. 553-567.

[3] Evans, J.R. and S. von Caemmerer, *Temperature response of carbon isotope discrimination and mesophyll conductance in tobacco.* Plant Cell and Environment, 2013. **36**(4): p. 745-756.