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# Soil organic carbon decomposition from recently added and older sources estimated by $\delta^{13}$C values of $CO_2$ and organic matter

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The production of $CO_2$ in soil strongly depends on the availability of organic carbon (C) for microorganisms. It is obvious, that C that entered the soil recently is more easily available for microorganisms in comparison to older C. However, only very few approaches allow for a quantitative estimation of the availability of C in relation to the time it is entering the soil. We hypothesized that $\delta^{13}$C values of $CO_2$ and of soil organic matter (SOM) after a C3 to C4 vegetation change will enable to calculate the relative availability of younger (C4-derived) and older C (C3-derived) sources for microorganisms. Soil $CO_2$ was sampled over one vegetation period at depths of 10, 40-50 and 60-70 cm at three treatments: a C3 reference (wheat), a C4/fallow (fallow after one year of maize cropping), and a C4/C4 (two years of maize cropping). Based on the $\delta^{13}$C of $CO_2$ purified from the admixture of atmospheric $CO_2$ by the Miller/Tans model and on the $\delta^{13}$C values of SOM, the contributions of younger and older C sources to $CO_2$ and SOM were assessed. Depending on the soil depth and the presence of living roots, the contribution of younger C to soil $CO_2$ ranged from 20 to 60%, but that to SOM was less than 5%. By comparing the contributions of older and younger C to $CO_2$ and SOM, we found that the relative availability of organics recently introduced into the soil (C4-derived) was about 7 times higher than the availability of C stabilized in soil for longer than one year (C3-derived). We concluded that simultaneous analysis of the $\delta^{13}$C values of both SOM and of $CO_2$ allows not only for the quantification of the $CO_2$ sources, but also for the estimation of the availability of soil C pools of different age for microorganisms.