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Carbon input by roots into the soil: Quantification of rhizodeposition from root to ecosystem scale

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Abstract

© 2017 John Wiley & Sons Ltd Despite its fundamental role for carbon (C) and nutrient cycling, rhizodeposition remains ‘the hidden half of the hidden half’: it is highly dynamic and rhizodeposits are rapidly incorporated into microorganisms, soil organic matter, and decomposed to CO2. Therefore, rhizodeposition is rarely quantified and remains the most uncertain part of the soil C cycle and of C fluxes in terrestrial ecosystems. This review synthesizes and generalizes the literature on C inputs by rhizodeposition under crops and grasslands (281 data sets). The allocation dynamics of assimilated C (after13C-CO2or14--CO2labeling of plants) were quantified within shoots, shoot respiration, roots, net rhizodeposition (i.e., C remaining in soil for longer periods), root-derived CO2, and microorganisms. Partitioning of C pools and fluxes were used to extrapolate belowground C inputs via rhizodeposition to ecosystem level. Allocation from shoots to roots reaches a maximum within the first day after C assimilation. Annual crops retained more C (45% of assimilated13C or14C) in shoots than grasses (34%), mainly perennials, and allocated 1.5 times less C belowground. For crops, belowground C allocation was maximal during the first 1–2 months of growth and decreased very fast thereafter. For grasses, it peaked after 2–4 months and remained very high within the second year causing much longer allocation periods. Despite higher belowground C allocation by grasses (33%) than crops (21%), its distribution between various belowground pools remains very similar. Hence, the total C allocated belowground depends on the plant species, but its further fate is species independent. This review demonstrates that C partitioning can be used in various approaches, e.g., root sampling, CO2flux measurements, to assess rhizodeposits’ pools and fluxes at pot, plot, field and ecosystem scale and so, to close the most uncertain gap of the terrestrial C cycle.

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Keywords

belowground carbon allocation, carbon cycle, crops, grasses, isotopic approaches, rhizosphere microorganisms, root exudation, soil CO efflux 2, trees

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