Plant and Soil 2017 vol.410 N1-2, pages 73-85

The above-belowground coupling of the C cycle: fast and slow mechanisms of C transfer for root and rhizomicrobial respiration

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Abstract

© 2016, Springer International Publishing Switzerland.Background and aims: The coupling of photosynthesis with belowground processes appears to be much faster than the time needed for assimilate translocation with the phloem flow. Pressure/concentration waves have been hypothesized to release belowground C already present in the phloem, resulting in a very fast feedback of rhizosphere processes to photosynthesis changes. We evaluate the speed of aboveground-rhizosphere coupling under maize by two mechanisms: pressure/concentration waves and direct phloem transport. Methods: We combined two isotopic approaches: 1) the speed of direct phloem transport was evaluated by labeling shoots in 14CO2 and tracing 14C in the nutrient solution and in the CO2 flux, 2) pressure/concentration waves were evaluated by labeling the solution with [13C] glucose and tracing the isotope dilution during photoassimilation. Results: 14C shoot labeling of maize plants showed that 12 h were needed for 14C to peak in root-derived CO2. In contrast, in the solution labeling approach, CO2 flux increased within 2 h after switching on the light. Pressure/concentration waves contributed 5 % to diurnal respiration efflux and affected only root respiration. Root exudation was independent of the fast mechanism of above-belowground coupling. Conclusions: Photosynthesis affected root and rhizomicrobial respiration on variable time-scales: root respiration within the first 2 h by pressure/concentration waves, whereas rhizomicrobial respiration may depend on internal circadian cycles in regulating exudation rather than on light directly.

http://dx.doi.org/10.1007/s11104-016-2982-2

Keywords

Phloem transport, Photosynthesis, Pressure/concentration waves, Rhizosphere, Soil respiration, Time lag

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