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Biomass Partitioning, Root Respiration and Canopy-Root Coupling in Juvenile Tropical Trees

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Trees in tropical forests are considered the largest component of the terrestrial biomass carbon stock. Yet, because of the inaccessibility of the root system little is known about root biomass partitioning, its implication to root system respiration and the coupling between tree canopy and root system. Our objectives were (1) to quantify biomass partitioning to above- and belowground organs, (2) to quantify the respiration rate (Rr) of different root diameter classes (RDCs), and (3) to evaluate canopy-root coupling and its potential underlying mechanisms in juvenile trees of two tropical forest species. To overcome the methodological constraints, we used a large aeroponics facility allowing direct access to the large root system of such trees. Most of the biomass was allocated to the shoot in both species. *Ceiba pentandra* allocated within the shoot more biomass to the stem and branches, while *Khaya anthotheca* allocated more to leaf blades. Most of root biomass was allocated to very coarse roots (diameter >10 mm) in *C. pentandra*, while in *K. anthotheca* biomass was allocated more evenly between RDCs. The different partitioning between the two species may indicate different resource aquisition strategies. Specific Rr of fine roots was highest among all RDCs in both species, while when upscaled to total RDCs biomass it was still highest in *K. anthotheca* and was only second to very coarse roots in *C. pentandra*. Root system respiration summed up from fluxes of the RDCs was comparable to Rr measured in a cuvette that sealed the entire root system. Our data shed light on Rr of RDCs and their significance to biogeochemical cycles. The discrepancy of Rr of different RDCs between the two species calls for cautious modeling. Simultaneous gas exchange measurements of leaf photosynthesis and fine root respiration under ambient and shade conditions showed a lagged response of fine roots to photosynthesis in *K. anthotheca*, while in *C. pentandra* the response was immediate. Proximal fine roots of *C. pentandra* exhibited higher Rr and stronger coupling to canopy activity than distal fine roots. Fine root respiration under ambient light conditions was higher and was better coupled to canopy activity than fine root respiration of trees under shade. Point dendrometers revealed a lagged response of phloem width changes to canopy activity in *C. pentandra*. Results indicate that two coupling patterns exist in *C. pentandra*: (1) an immediate canopy-root coupling, which is not based on the mass transport of carbohydrates in the phloem, but rather on a mechanism of fast information flow, and (2) a lagged coupling which is based on the mass flow in the phloem sap. In *K. anthotheca*, only a lagged coupling was observed, indicating mass flow in the phloem as the only coupling mechanism. Our experimental study improves understanding of carbon dynamics in fast growing tropical trees: biomass partitioning, including the entire root system; respiration by roots of various categories and their contribution to total tree respiration; and the potential mechanisms underlying the coupling of canopy and root carbon dynamics in juvenile tropical trees.