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Inter-plant C Transfer and Associations between Plant-assimilated C Inputs and Soil Pores

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Greater plant diversity facilitates soil C gains, yet the exact mechanisms of this effect are still under intensive discussion. Whether a plant grows in monoculture or in an inter-cropped mixture can affect allocation of plant assimilates, belowground exudation, and microbial stimulation. The goal of this study was to examine the effects of inter-cropping on a previously overlooked aspect of plant-soil interactions, namely, on locations where plant assimilated C is allocated within the soil pore system and its subsequent fate in relation to soil pores. The soil for the study originated from a greenhouse experiment with switchgrass (Panicum virgatum L.) (var. Cave'n'Rock) (SW), big bluestem (Andropogon gerardii Vitman) (BB), and wild bergamot (Monarda fistulosa L.) (WB) grown in monocultures and in inter-cropped pairs and subjected to species specific C pulse labeling (Kravchenko et al., 2021). Intact soil cores (8 mm Ø) were collected from the experimental pots, subjected to a short-term (10 day) incubation, X-ray computed micro-tomography (µCT) scanning, and soil C micro-sampling "geo-referenced" to µCT images. Results indicated that in the plant systems with demonstrated interplant C transfer soil C was positively correlated with <10 µm Ø pores immediately after plant termination and with 20-80 µmØ pores after the incubation. In the systems without marked interplant C transfer, soil C was positively correlated with 20-30 µm Ø pores, however, the correlations disappeared after the incubation. Soils from the systems with demonstrated belowground C transfer displayed lower losses of root-derived C during incubation than the systems where interplant C transfer was negligible. These differences suggest dissimilarities in the possible mechanisms of adding photoassimilated C to the soil: via mycorrhizal hyphae into small sized pores vs. via roots into mediumsized pores. In the latter case the plant-derived C was quickly lost during subsequent incubation. Our findings indicate that greater losses of plant assimilated C from the soil often reported during comparisons of monocultures with inter-cropped plant mixtures are related not only to monoculture vs. polyculture dichotomy, but to the route of plant C additions to the soil and its localization within the soil pores.