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Arbuscular mycorrhiza enhances soil C sequestration by higher rhizodeposition and reduces soil organic matter decomposition

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Arbuscular mycorrhizal fungi (AMF) represent an important route for plant carbon (C) input to soil, and regulate below-ground organic matter (SOM) storage. However, the C sequestration depends on plant C input and rhizosphere priming effect (RPE), and both processes affected by AMF colonization, which makes the C balance under AMF remains largely unknown. A mycorrhizal wild type progenitor (MYC) and its mycorrhiza defective mutant of tomato (reduced mycorrhizal colonization: rmc) were used to control the formation of AMF symbiosis. The plants were labelled with 15N mineral fertilizer and continuously $13CO_2$. AMF symbiosis decreased relative C incorporation (% of total assimilated C) into roots, but increased the net rhizodeposition and C incorporated into soil. N fertilization decreased relative C incorporation into roots, rhizosphere, and bulk soil. However, the absolute amount of rhizodeposition remaining in soil was not changed by fertilization. A positive RPE was observed for both MYC and rmc plants, which ranging from 16-71% and 25-101% of native SOM decomposition, respectively. Remarkably, the positive RPE induced by AMF was decreased with plant age, which may associate with the increased nutrients competition between AMF and free-living decomposers in rhizosphere. The RPE and extracellular enzyme activities decreased with N fertilization compared with unfertilized soil at 8 and 12 weeks after transplanting, suggesting N fertilization decreased microbial N demand through SOM mining. Sixteen weeks after transplanting, the amount of rhizodeposits remained in rhizosphere and bulk soil by MYC was 0.02-0.04, 1.67-1.75 mg C kg-1, which accounted for 0.7-1.1% and 42-46% of belowground plant C, respectively. The rhizodeposition remaining in SOM for rmc was three times lower than that for MYC plant. We conclude that AMF symbiosis and N fertilization facilitates C sequestration in soil not only by higher plant C input, but also by reducing native SOM decomposition.