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Nutrient effects on plant carbon allocation – the role of mycorrhizal fungi

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Climate being equal, forests on fertile soils have higher photosynthesis and produce more biomass. They even produce this biomass more efficiently (higher biomass production-to-photosynthesis ratio) and because also soil respiration (as a fraction of photosynthesis) is smaller for nutrient-rich soils, net ecosystem productivity is higher in soils of high as compared to low nutrient availability. But why is this? Do plants on fertile soil respire a smaller fraction of their photosynthates? Or do they allocate less to typically unaccounted for compartments like mycorrhizae and exudates? We set up a mesocosm N and P fertilization experiment to disentangle the mechanisms. In order to distinguish newly fixed carbon from carbon already present in the soil, we opted to grow the C4 plant Zea mays on a C3 soil. This enabled estimating mycorrhizal biomass based on the difference in d13C natural abundance between fresh plant carbon and old soil carbon. We determined photosynthesis at ecosystem and leaf level, leaf respiration, and above-and belowground plant biomass production, and measured root exudation. As expected, fertilization increased the biomass production-to-photosynthesis ratio of the plants; i.e. fertilization increased the biomass production efficiency. Our results suggest no difference in the fraction of photosynthates being respired by the plant, but a substantial reduction in carbon partitioning to the mycorrhizal fungi in fertilized as compared to unfertilized plots.