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The role of mycorrhizal fungi in integrated carbon and nitrogen cycles

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Understanding the role of terrestrial ecosystems in removing carbon dioxide (CO_2) from the atmosphere remains one of the fundamental challenges to predicting future changes in the Earth's climate. Will forests continue to sequester carbon (C) under rising atmospheric CO_2 and nitrogen (N) deposition, or will the capacity of trees to build new biomass be constrained by lack of nutrients? Recent research shows that not all tree species react similarly to N-deposition; differences are found in growth rates, survival and C-storage.

Mycorrhizal fungi are an important link in coupling the C and N cycles and are critical for tree growth. Mycorrhizal fungi form mutualistic relationships, receiving carbohydrates from their plant hosts and in return enhancing the supply of critical nutrients. The two most abundant mycorrhizal associations are arbuscular mycorrhizae (AM) and ectomycorrhizae (EM), both having different mechanisms of N acquisition, which may explain observed differences in tree species response to N-deposition.

Changing environmental variables influence mycorrhizal fungi. Increasing CO_2 concentration increases mycorrhizal abundance, growth and plant C allocation belowground. However, the effect of N-deposition on mycorrhizae is less clear. N-deposition can have positive, neutral or negative effects on mycorrhizal abundance and growth. It has been hypothesized that the effect of N-deposition on mycorrhizal growth depends on initial soil nutrient status. This soil nutrient status may also determine the nature of the mycorrhizal relationship to the tree, where in nutrient poor conditions, they could be more beneficial than in nutrient rich conditions. In this research, we extend the hypothesis to include growth of trees associated with either EM or AM, as a function of increasing nitrogen deposition and soil nutrient status. Therefore, we take into account the C-cost and the N-gain of the mycorrhizal fungi for the tree in the different nutrient stages.