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Sara Marañon-Jimenez, Dajana Radujkovic, Matthias Cuntz, Erik Verbruggen, Marion Schrumpf, et al.. The contribution of ectomycorrhizal fungi to litter decomposition may imply synergistic controls of above- and belowground vegetation on soil CO2 emissions. EGU 2018, European Geophysical Union General Assembly 2018, Apr 2018, Vienne, Austria. 2018. hal-02733693

HAL Id: hal-02733693
https://hal.inrae.fr/hal-02733693

Submitted on 2 Jun 2020

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Geophysical Research Abstracts
Vol. 20, EGU2018-17387-1, 2018
EGU General Assembly 2018
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The contribution of ectomycorrhizal fungi to litter decomposition may imply synergistic controls of above- and belowground vegetation on soil CO_2 emissions

Sara Marañón-Jiménez, Dajana Radujkovic, Matthias Cuntz, Erik Verbruggen, Marion Schrumpf, and Corinna Rebmann

Spain (smaranon@ugr.es)

The stimulation of vegetation productivity in response to rising atmospheric CO_2 concentrations can potentially compensate climate change feedbacks. Vegetation and soil C storage will be however limited by nutrient availability, the allocation of C resources of vegetation into aboveground biomass versus roots and on the feedbacks with soil microorganisms. Plants can modulate the amount of carbon that is allocated to above- versus belowground in response to changing atmospheric CO_2 concentrations, with a consequent alteration of productivity and of the litter and rhizosphere inputs to the soil. Recent studies have highlighted the crucial role of mycorrhizal fungi on the response of vegetation productivity to rising CO_2 concentrations. We hypothesize that mycorrhiza can also play a key role on litter decomposition for N acquisition, therefore affecting CO_2 emissions and the amount C sequestered into the soil.

In order to test this hypothesis, different levels of litter addition were implemented on trenched (root exclusion) and non-trenched plots (with roots) in a temperate deciduous forest of ectomycorrhiza-associated species (beech and oak). Soil CO_2 fluxes were continuously measured at high temporal resolution with automatic chambers, whereas the spatial and seasonal variability was determined using portable chambers. The composition of saprobiotic and symbiotic fungal communities were determined in each treatment after 2 years, as well as the changes in soil C and N stocks.

Soil CO_2 effluxes showed a synergistic interaction between the increased litter inputs and the presence of roots, where the carbon mineralized in response to litter addition was much higher in the non-trenched plots. DNI sequencing of fungal communities confirmed that trenching succeeded in suppressing virtually all ectomycorrhizas. Litter manipulation (exclusion, control, doubled addition) showed a linear relationship with ectomycorrizal (ECM) strains of divergent exploration types, where the litter exclusion treatment was dominated by ECM of short exploration types and long exploration ECM types dominate at double litter. These results together suggest that long exploration types of ECM may contribute to litter decomposition for N and/or other nutrients, thus enhancing CO_2 fluxes and N acquisition by plants. Therefore, the association of plants with ectomycorrhizal fungi not only may determine the productivity responses to rising atmospheric CO_2 concentrations, but also the rates of litter decomposition and N cycling.