How Fungi can Slow Climate Change: Impact of Mycorrhizae on Terrestrial Carbon Sinks Under Elevated CO₂ Levels

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INTRODUCTION
Atmospheric CO₂ concentrations have risen 50%+ above pre-industrial levels since the mid-1700s, a trend that will continue to warm the Earth for thousands of years. This study explores the crucial role of mycorrhizal fungi in mitigating carbon capture, and investigates mycorrhiza’s potential as a natural solution to slow global warming.

BACKGROUND / HYPOTHESIS
Terrestrial carbon sink, or soils’ ability to sequester carbon from the atmosphere, can mediate Earth’s carbon cycle. Yet the amount of land is insufficient to keep up with anthropogenic emissions (Walker, 2020, p. 24).

Mycorrhizal fungi form symbiotic networks with plant roots and can enhance or diminish the Earth’s giant soil organic carbon (SOC) pool of ~1,500 gigatons (Gt). Therefore, it is imperative to identify which mutualistic relationships can effectively increase the ecosystem’s future land carbon sink.

Hypothesis: As CO₂ levels increase, certain mycorrhizae have the potential to sequester additional levels of carbon relative to most policy or technological offsets.

RESEARCH METHODOLOGIES
This study used R language for statistical computing to quantify the effect of each fungi-biome on soil organic carbon (SOC) levels. A meta-analysis of 123 global CO₂-enrichment experiments focused on Arbuscular mycorrhiza (AM) and ectomycorrhiza (EzM), which colonize over 77% of vegetated biomes. Additionally, a multivariate regression was performed to predict the gains in SOC resulting from applying optimal fungi-biome combinations in ecosystem restoration.

RESULTS / FINDINGS
Earth contains ~472 million hectares of abandoned agricultural land and ~2 billion hectares of deforested land. Simulation results from this study suggest that the inoculation of AM fungi during re-vegetation of these lands could increase soil carbon storage by weighted means of 12.6% or 118 grams per m², when CO₂ levels projected from 372 ppm (~year 2000) to 616 ppm (~year 2100). AM symbioses could offset anthropogenic emissions by 9.5 to 15 Gt CO₂ equivalent, lowering global temperatures by ~0.5°C.

CONCLUSIONS
AM mycorrhizae have the potential to lower global temperatures by ~0.5°C naturally. AM shows significant promise in increasing the ecosystem’s future land carbon sink to remedy the greatest global environmental threat.

ACKNOWLEDGEMENTS / REFERENCES
Special thanks to Ms. Hilary McDaniel (Palo Alto High School), Professor Francis Niccoli (Foothill College), Professor Jeff Anderson (Foothill College), and Professor César Terrer (MIT) for helping make this project possible.

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