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Fungi could be essential to reaching net zero

Study shows it can store a third of carbon from fossil fuel emissions

Mycorrhizal fungi have been supporting life on land for at least 450 million years by helping to supply plants with soil nutrients essential for growth. In recent years, scientists have found that in addition to forming symbiotic relationships with nearly all land plants, these fungi are important conduits to transport carbon into soil ecosystems.

In a new study published in the journal *Current Biology*, scientists estimated that as much as 13.12 gigatons of carbon dioxide equivalents (CO2e) fixed by terrestrial plants is allocated to mycorrhizal fungi annually — roughly equivalent to 36% of yearly global fossil fuel emissions.

Because 70% to 90% of land plants form symbiotic relationships with mycorrhizal fungi, researchers have long surmised that there must be a large amount of carbon moving into the soil through their networks.

Dr Heidi Hawkins, lead author and research associate on plant-soil-microbe interactions at the University of Cape Town, said: "We always suspected that we may have been overlooking a major carbon pool. Understandably, much focus has been placed on protecting and restoring forests as a natural way to mitigate climate change. But little attention has been paid to the fate of the vast amounts of carbon dioxide that are moved from the atmosphere during photosynthesis by those plants and sent below ground to mycorrhizal fungi."

Mycorrhizal fungi transfer mineral nutrients to and obtain carbon from their plant partners. These bi-directional exchanges are made possible by associations between fungal mycelium, the thread-like filamentous networks that make up the bulk of fungal biomass, and plant roots. Once transported underground, carbon is used by mycorrhizal fungi to grow a more extensive mycelium, helping them to explore the soil. It is also bound up in soil by the sticky compounds exuded by the fungi and can remain underground in the form of fungal necromass, which functions as a structural scaffold for soils.

The scientists know that carbon is flowing through fungi, but how long it stays there remains unclear. "A major gap in our knowledge is the permanence of carbon within mycorrhizal structures. We do know that it is a flux, with some being retained in mycorrhizal structures while the fungus lives, and even after it dies," said Hawkins. "Some will be decomposed into small carbon molecules and from there either bind to particles in the soil or even be reused by plants. And certainly, some carbon will be lost as carbon dioxide gas during respiration by other microbes or the fungus itself."

Hawkins added that the ericoid fungi, both globally and locally in the Cape Floristic Region, are particularly under researched.

The paper is part of a global push to understand the role that fungi play in Earth's ecosystems. "We know that mycorrhizal fungi are vitally important ecosystem engineers, but they are invisible," noted senior author Toby Kiers, a professor of evolutionary biology at Vrije University Amsterdam and co-founder of the Society for the Protection of Underground Networks. "Mycorrhizal fungi lie at the base of the food webs that support much of life on Earth, but we are just starting to understand how they actually work. There's still so much to learn."

But there's a race against time to understand and protect these fungi. The United Nations Food and Agriculture Organization warns that 90% of soils could be degraded by 2050, and fungi are left out of most conservation and environmental policy. Without the fertility and structure that soil provides, the productivity of both natural and crop plants will rapidly decline.

"Mycorrhizal fungi represent a blind spot in carbon modeling, conservation, and restoration," said co-author Katie Field, a professor of plant-soil processes at the University of Sheffield. "Soil ecosystems are being destroyed at an alarming rate through agriculture, development, and other industry, but the wider impacts of disruption of soil communities are poorly understood. When we disrupt the ancient life support systems in the soil, we sabotage our efforts to limit global heating and undermine the health and resilience of the ecosystems on which we depend."

The researchers emphasised that while their figures are based on the best available evidence, they are imperfect and should be interpreted with caution.

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