Letting crop residues rot in the field is a climate win

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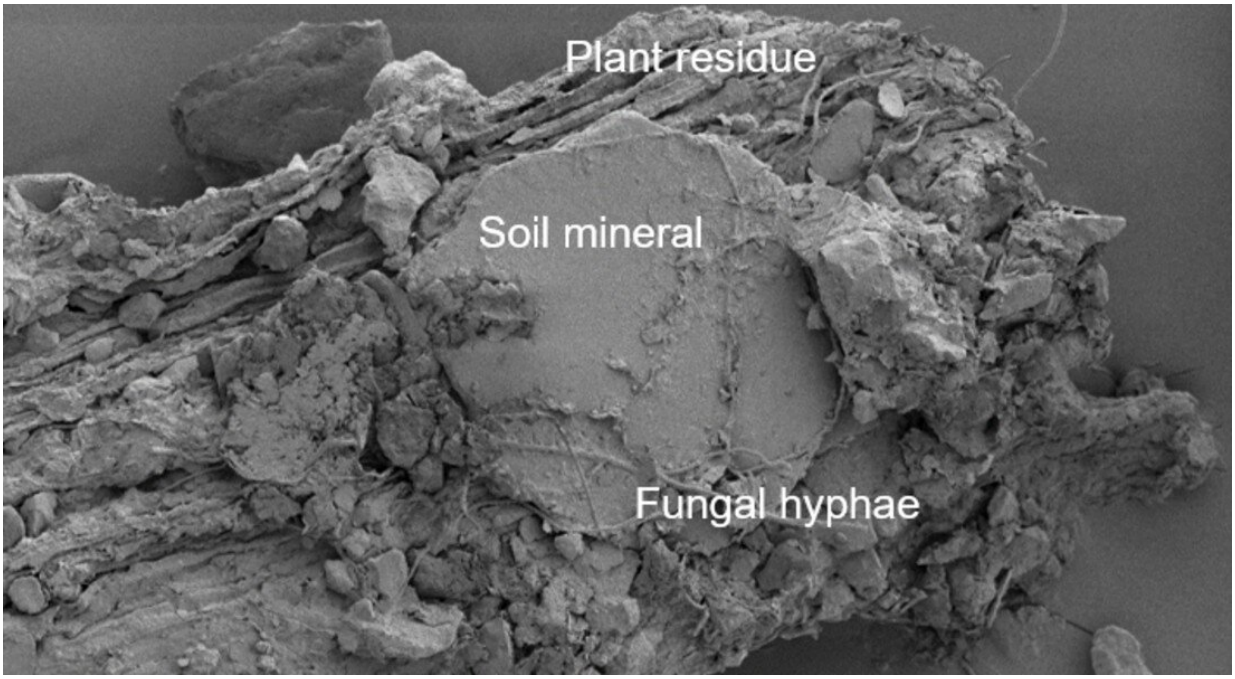

Close-up of how plant residues are being protected in the soil mineral and glued together by fungal hyphae. A process that prevents carbon from being emitted as CO_2. Credit: Carsten W. Müller.

For quite some time, farmers and researchers have been focusing on how to bind carbon to soil. Doing so makes food crops more nutritious and increases yields.

However, because carbon is converted into CO_2 when it enters the atmosphere, there is a significant climate benefit to capturing carbon in soil as well.

Too much carbon finds its way into the atmosphere. Should we fail to reverse this unfortunate trend, we will fail to achieve the Paris Agreement's goal of reducing greenhouse gas emissions by 40 percent by 2030, according to CONCITO, Denmark's Green Think Tank.

As such, it is important to find new ways of sequestering carbon in soil. This is where a team of researchers from the University of Copenhagen and the Technical University of Munich enter the picture.

In their new study, they argue for the potential of simply allowing agricultural crop residues to rot in fields.

"Fragments of dead plants in soil are often considered as fast food for microbes and fungi. But our study demonstrates that plant residues actually play a more significant role in forming and sequestering carbon in soil than what was once thought," explains Kristina Witzgall, a Ph.D. Candidate at the Technical University of Munich and the study's lead author.

In the past, researchers mainly focused on carbon storage in the surfaces of minerals like clay. However, the new results demonstrate that plant residues themselves have the ability to store carbon, and perhaps for longer than once supposed.

This is because a number of important processes take place directly upon the surface of these plant remains.

"We demonstrate that agricultural crop residues are absolutely central to carbon storage and that we should use them in a much more calculated

way in the future. Plant residues make it possible for carbon, in all likelihood, to be stored in soil for roughly four times longer than if they aren't added," states Carsten Müller, the study's co-author and an associate professor at the University of Copenhagen's Department of Geosciences and Natural Resource Management.

Fungi and soil clumps store carbon

To understand how plant residue sequesters carbon, it is important to know that plant tissue already contains carbon absorbed by plants from the atmosphere via photosynthesis. As plant matter rots, carbon can be transferred into the soil in a number of ways.

"Our analysis shows that plant residues, as they interact with fungi, play a surprisingly large role in carbon storage. As fungi fling their white strands around plant fragments, they 'glue' them together with the soil. The fungi then consume the carbon found in the plant matter. In doing so, they store carbon in the soil," explains Müller.

In addition to fungi, the researchers' analyses also show that the soil structure itself determines the amount of carbon that can be stored.

"When soil is glued together in large hard lumps by the stickiness of bacteria and fungi, plant residues are shielded from being consumed by bacteria and fungi, which would otherwise eat and then emit some of the carbon as CO_2 into the atmosphere," says Witzgall.

She goes on to say that while carbon can be stored in soil from weeks to a thousand years, the usual duration is about 50 years.

Reducing CO_2 in the future

The method of leaving crop residues like stalks, stubble and leaves to rot

is not unheard of when it comes to enhancing agricultural land.

However, deploying rotten plants as a tool to store carbon should be taken more seriously and considered as a strategy to be expanded, according to the researchers behind the new study.

"The fertile and climate-friendly agricultural lands of the future should use crop residue as a way of sequestering carbon. We will also be conducting experiments where we add rotten plant matter deeper into the soil, which will allow carbon to be stored for even longer periods of time," says Müller.

If we work to create better conditions for carbon sequestration in soil, we could store between 0.8 and 1.5 gigatonnes of carbon annually. By comparison, the world's population has emitted 4.9 gigatonnes of carbon per year over the past 10 years.

All in all, the researchers' findings can be used to understand the important role and promise of crop residues for carbon storage in the future.

However, Witzgall goes on to say that a variety of initiatives are needed to increase carbon sequestration, such as crops that can absorb atmospheric carbon and the restoration of lost forests.

More information: Kristina Witzgall et al, Particulate organic matter as a functional soil component for persistent soil organic carbon, *Nature Communications* (2021). DOI: 10.1038/s41467-021-24192-8

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