Cooking better biochar: Study improves recipe for soil additive

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This is Rice biogeochemist Caroline Masiello. Credit: Jeff Fitlow/Rice University

Backyard gardeners who make their own charcoal soil additives, or biochar, should take care to heat their charcoal to at least 450 degrees Celsius to ensure that water and nutrients get to their plants, according to a new study by Rice University scientists.

The study, published this week in the *Journal of* Biomass and Bioenergy, is timely because biochar is attracting thousands of amateur and professional gardeners, and some companies are also scaling up industrial biochar production.

"When it's done right, adding biochar to soil can improve hydrology and make more nutrients available to plants," said Rice biogeochemist

Caroline Masiello, the lead researcher on the new study.

The practice of adding biochar to topsoil to boost crop growth goes back centuries, but in recent years, international interest groups have begun touting biochar's climate benefits as well. Biochar removes carbon from the atmosphere and locks it into the soil for hundreds and sometimes thousands of years.

With companies scaling up production and dozens of do-it-yourself videos online showing how to make biochar at home, Masiello said it is important for scientists to study examine how biochar is produced and learn which methods produce the best biochar.

In their study, Masiello's team learned that when it comes to helping get water to plants, not all forms of biochar are the same. The researchers found charcoal produced at temperatures of 450 Celsius or higher was most likely to improve soil drainage and make more water available to plants, while charcoal produced at lower temperatures could sometimes repel water.

Rice's award-winning biochar research group examined the hydrologic properties of biochar produced at various temperatures from three kinds of feedstock -- tree leaves, corn stalks and wood chips. For all feedstocks, the researchers found that biochar produced at temperatures above 450 degrees Celsius (842 degrees Fahrenheit) had optimal properties for improving soil drainage and storing carbon.

The research team included Rice undergraduate Tim Kinney, Bellaire High School science teacher Michelle Dean and Rice faculty members, Brandon Dugan, assistant professor of Earth science, and Kyriacos Zygourakis, the A.J. Hartsook Professor in Chemical and Biomolecular Engineering. Other team members were William Hockaday, now an assistant professor of geology at Baylor University in Waco, Texas, and

Rebecca T. Barnes, now a visiting assistant professor at Bard College in Annandale-on-the-Hudson, New York.

Making charcoal may sound like a strange way to boost crop production, but the concept was proven more than 2,000 years ago in South America, where native farmers added charcoal to the poor soils of the Amazon rainforest to create a rich, fertile soil known by the Portuguese name "terra preta," or black earth. These modified soils, which are still fertile today, contain as much as 35 percent of their organic carbon in the form of charcoal. Studies over the past decade have found that the charcoal-amended soil holds more water and nutrients and also makes the water and nutrients readily available to plants.

The charcoal, or biochar, that is used to create such soil can be made from wood or agricultural byproducts. The key is to heat the material to a high temperature in an oxygen-starved environment. Native Americans did that by burying the material in pits, where it burned for days. Today, industrial-scale biochar production is beginning to occur, and dozens of do-it-yourself videos online show how to make biochar in just a few hours using steel drums.

The agricultural benefits of biochar are just one reason there's a groundswell of interest in biochar production. Some enthusiasts are drawn by a desire to fight global warming. That's because about half of the carbon from wood chips, corn stalks and other biomass -- carbon that typically gets recycled into the atmosphere -- can be locked away inside biochar for thousands of years.

"When people mow their yards here in Houston, the carbon from the grass clippings returns to the atmosphere in about six weeks," said Masiello, assistant professor of Earth science at Rice. "We call this carbon-cycling, and it's a universal process. Making biochar is one way to remove carbon from the atmosphere and lock it away for a long time."

Masiello, who specializes in studying the carbon cycle, said the microscopic properties of biochar can vary widely depending upon how it's made. In the worst case, she said, improperly made biochar can harm soil rather than improve it.

"This is the first rigorous study of the hydrologic aspects of biochar," Masiello said. "People often tout the benefits of biochar; it can help clay-rich soils drain better, and it can help sandy soils hold water better. But we are finding that these hydrologic benefits vary widely with biochar production conditions."

She said the study found that biochar produced at temperatures lower than 450 degrees Celsius retained some organic compounds that can actually repel water rather than attract it. In addition, the study found that lower-temperature biochar was a less stable reservoir for carbon and could return significant amounts of carbon to the atmosphere within a few hundred years.

"We plan to study ways to optimize other beneficial properties of biochar, including its ability to remove heavy metals and other pollutants from soil," Masiello said. "Ultimately, we'd like to publish a how-to guide that would show exactly what conditions are needed to produce the optimal biochar for a given situation."

More information: www.sciencedirect.com/science/ … ii/S0961953412000438

Provided by Rice University

https://phys.org/news/2012-03-cooking-biochar-recipe-soil-additive.html