

Biochar: *A Game-Changer for Soils*

By Dave Story

Everything old is new again. That certainly holds true for biochar, a type of charcoal first produced and used in the Amazon basin centuries ago to make agricultural land more fertile. Biochar results from heating plant waste, or biomass, at high temperatures in little or no oxygen. The process, called pyrolysis, also takes place in naturally occurring fires resulting from lightning strikes. Not only does biochar help soils retain nutrients and moisture, but it remains effective in the soil for hundreds of years – all of which means it can help you better and more efficiently protect the health of your clients' landscapes.

Ancient yet modern

As the nonprofit U.S. Biochar Initiative explains, "biochar has been created and used by humans in traditional agricultural practices in the Amazon Basin of South America for more than 2,500 years. Dark, charcoal-rich soil (known as terra preta, or black earth) supported productive farms in areas that previously had poor and, in some places, toxic soils."



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"Terra preta was discovered in the 1950s by Dutch soil scientist Wim Sombroek in the Amazon rainforest. It still covers 10 percent of the Amazon Basin. Similar sites have been found in Ecuador, Peru, Benin and Liberia in West Africa."

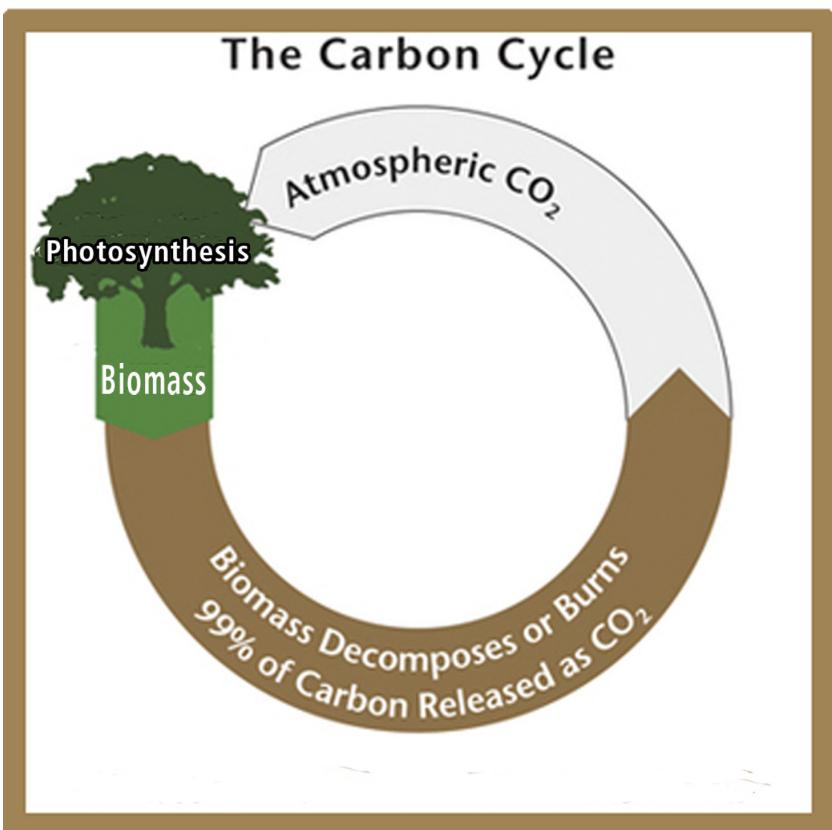
Over the past 10 years, researchers have been investigating terra preta, now called biochar, as an agricultural resource. They have been interested not only in its value for plant cultivation but also for its potential to address urgent environmental issues, including climate change. Typically when biomass decomposes or burns, virtually all of the carbon stored in the plant is released into the atmosphere as carbon dioxide, a greenhouse gas that contributes to global warming. But when biochar is produced, roughly half of the plant's carbon is retained as stable carbon in the biochar. The other half is released as wood gases, which can be used as an energy source.

This biochar cycle puts carbon from the atmosphere back into the earth, puts it to positive use in the soil and increases the amount of time it stays there.

Moisture Management and Nutrient Storage

So why is biochar such a valuable soil amendment? According to Hugh McLaughlin, Ph.D., P.E., a chemical engineer who has been an advisor to the nonprofit International Biochar Initiative and is director of biocarbon research at Alterna Biocarbon Inc.,





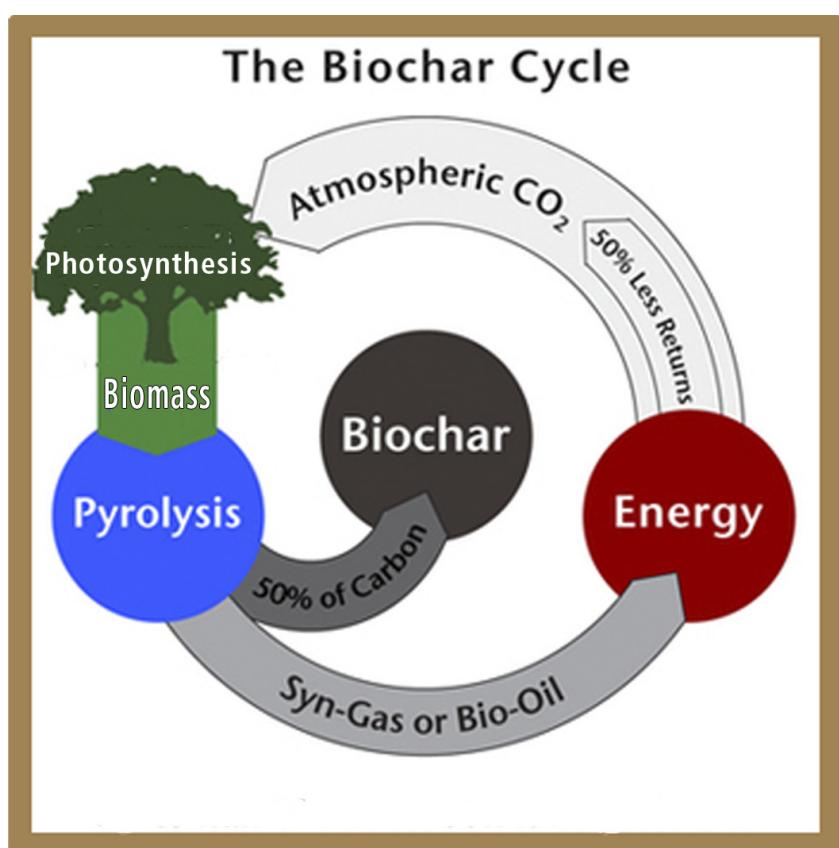
This is the first of two articles on biochar, a potent soil amendment for urban and suburban landscapes.

the principle contribution of biochar is “a combination of moisture management and providing a way to store microbial food and plant fertilizer. When there is an excess of water, food and fertilizer, biochar stores them. When there is a deficiency, it slowly releases them back into the soil, where the plant or microbes can take advantage of them.”

Dr. McLaughlin explains what he calls a subtle but critical concept about the symbiotic relationship between plants and soil microbes. In traditional growing practices, a plant receives its moisture from the soil. Through photosynthesis it combines the water with carbon dioxide to produce sugar that it uses to grow. It also exports some of that sugar through its roots to feed soil microbes. The microbes in turn provide nutrients – both macronutrients and micronutrients – back to the plant.

Adding a nitrogen-phosphorous-potassium fertilizer removes the plant’s need to work with the microbes. Since it receives needed macronutrients from the fertilizer, the plant stops sending sugar to the microbes and uses all of it to grow. But there’s a problem: the plant no longer receives a balanced diet because the microbes

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no longer produce the micronutrients it needs. And that can impact its long-term plant health.

Biochar reduces the need for NPK fertilizers, cultivates beneficial soil microbes and, because the plant has better overall health and is less susceptible to pests, reduces the need for pesticides.

Like a wet sponge

What makes this possible is biochar's ability to adsorb, says Dr. McLaughlin. Not to be confused with absorption, adsorption involves voids in one substance taking up another substance.

He uses the example of a wet sponge: When you wring it out, you remove the

liquid in it. When you place it in a pail of water, water flows in and takes up the voids.

Biochar is highly adsorbant. It adsorbs humic acid, which is a food source for soil microbes. And humic acid adsorbs fertilizers, keeping them from leaching out of the soil.

Biochar is also highly adsorbant of water. As it turns out, in conditions with greater than 60 percent relative humidity, biochar fills all its adsorption sites with water. Below 40 percent, it releases all the water. That makes it an enormous stabilizer of relative humidity in soils, which means less watering.

One growing situation in which biochar's ability to reduce the need for

water and fertilizers is particularly valuable is the urban tree pit. Bartlett Tree Experts and The Morton Arboretum are researching biochar in those and other urban and suburban applications. (More on that in the second article of this series next month.)

All biochars are not created equal

So let's say you would like to use biochar on your clients' properties. You can just buy a bag and start applying it to the soil, right? You could, but you would need to do your due diligence first to know what you're getting.

Different biochars have different qualities.

In 2009, the International Biochar



Initiative began developing standards for biochar. Its initial focus has been on ensuring that biochar products are safe and contain no toxins. The next step necessary, says Dr. McLaughlin and others in the industry, is labeling that describes measurable characteristics of the biochar that relate to quality and performance, more along the lines of nutritional labeling for foods. This is especially important since different sources of biomass and different production methods and equipment can dramatically affect the quality and properties of the biochar produced.

Some biochar producers run their own tests and/or send their product to third-party labs for analysis. Jonah

Levine, cofounder and vice president of Biochar Solutions Inc. and special projects lead for Biochar Now, which makes Bartlett Tree Experts' Premium Landscape Biochar, says, "The way we achieve standards as a company is to measure materials coming in and going out, and we track that data. In our equipment we're tracking data multiple times per second in the process ... I run the statistics on those numbers and characterize the biochar at a third-party lab."

The informed buyer

So what should consumers of biochar watch for? Water, for one. "When you look at a bag of char," says Dr. McLaughlin, "depending on how that

char was created and packaged, there could be a lot of water in it. "While that's not a bad thing, it's probably not worth buying for the price. The label ought to admit that when you're holding this nice heavy bag of char, it's mostly water."

Another component to look for is ash. It may include the traditional inorganic NPK plant fertilizers, which you may already be adding to the soil separately from the char. 'It's not practical to supply your fertilizer needs by providing a lot of char,' says Dr. McLaughlin. "Most clean chars, made from woody or pure biomass, are only about 1 percent to 2 percent ash."

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In addition to water and ash content, the big properties to watch for are bulk density and adsorption capacity. Biochar opens up soil and aerates it. Bulk density is important in predicting the extent to which it will do that, and lower bulk densities are better. If the soil is full of clay, lower-density char will help prevent the clay from sealing up. With sandy soil, which has plenty of drainage and aeration, adsorption capacity is more important – a higher adsorption capacity can help retain the soil moisture.

So what's a biochar buyer to do? Mr. Levine suggests going online and looking for a company that has the right types of credentials. "It will be a company that has people who have been involved in the industry for several years," he says. "It will have engineers, business professionals. It will be testing with third-party labs, government agencies. It will have case studies in the ground."

Predicting performance

Beyond characterizing biochar, what will be even more valuable to the landscape industry will be the ability to provide predictors for how the biochar will perform. Mr. Levine uses the analogy of childhood nutrition. "It's hard to say how

childhood nutrition impacts the health of a 40-year-old," he says. "So the characterization of a particle of biochar is less important than how those qualities will affect the plant."

"Biochar characterization is still a conversation of what exactly is that biochar particle. But what does that mean to the end user? The biochar community has not in the past understood that need."

He's optimistic, though, pointing out that the conversation about getting biochar production into compliance began a mere five years ago. "That's fast for creating standards in what could be a 30-year process," he says. 

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