Biochar: What is it and why do Master Gardeners care?

From Wikipedia (not always considered "science-based")

Biochar is charcoal used as a soil amendment. Like most charcoal, biochar is created by pyrolysis of biomass. Biochar is under investigation as an approach to carbon sequestration to produce negative carbon dioxide emissions. Biochar thus has the potential to help mitigate climate change, via carbon sequestration. Independently, biochar can increase soil fertility of acidic soils (low pH soils), increase agricultural productivity, and provide protection against some foliar and soil-borne diseases. Furthermore, biochar reduces pressure on forests. Biochar is a stable solid, rich in carbon, and can endure in soil for thousands of years.

Edited from UCCE Green Blog, 2013:

The origins of interest in biochar, a charcoal-based soil amendment, are almost mythic in nature. In the Amazon Basin, a rainforest region with typically infertile soils, segments of soil have been discovered to be almost black in color and rich in nutrients. The soil's color, called "amazon dark earth soils", is derived from its high organic matter content, believed to originate from historical charcoal applications added to the soil some 2,500 years ago, either intentionally or as a waste product from cooking.

The charcoal, called biochar when used as a soil amendment, can be derived from nearly any biomass, transforming waste products into this unique additive. Increased bio-fuel production and increased fruit and nut crops in California produce a growing supply of waste that has rich potential as a nutrient. Wood, chicken manure, the residue of corn plants after harvest, and nut shells are all common candidates for biochar, each cooked down in a low- or no-oxygen environment into brittle charcoal and added to soil.

The claims of biochar's ability to improve soil are vast. Biochar proponents say its addition to soil can increase carbon storage, increase the nutrient and water retention of soils, and reduce the greenhouse gas emissions from soils.

"The basic premise of biochar's benefit is straightforward," says Sanjai Parikh, assistant professor of soil chemistry at UC Davis. "You are putting highly condensed carbon in the soil, so that biochar itself has a longer residence time that just putting a piece of wood, or any raw biomass, in the soil. The fact that biochar is a fairly recalcitrant form of carbon means that microbes cannot utilize it easily as food source and carbon dioxide emissions are thus temporarily reduced. However there is also a lot of excitement around the potential of biochar to also provide a host of specific agronomic benefits."

But as a relatively young avenue of scientific research, conclusive evidence of its benefits is largely inadequate. To drive forward the understanding of biochar, Parikh, has created the UC Davis Biochar Database (biochar.ucdavis.edu) a forum dedicated to comparing the physical and chemical properties of biochar based on the various sources used to make them, and through that generate a broader understanding of the replicable benefits biochar can bring to soil.

"With our database we're hoping to provide some of the basic data to the biochar community to link these benefits with specific biochar feedstocks and processing temperatures," Parikh said. "We released the database with 80 entries, and currently have over 300, but our goal is to grow the database to include 1,000 entries within a year," Parikh said. "There needs to be a place to come to understand the properties of biochar, and opening the forum for community contributions is an important way to expand our knowledge."

Master Gardener involvement in research

Since 2012, University of Minnesota Extension Master Gardeners and Iowa State Master Gardeners have been helping researchers answer the question: "Is biochar (charred organic matter) a good soil amendment for home gardens?" To do that, Extension Master Gardener volunteers have been testing the productivity of vegetables and flowers in gardens amended with biochar at four sites in Minnesota and three sites in Iowa.

Each year, the demonstration gardens are planted with common vegetable and bedding plants such as tomatoes, green bell peppers, cucumbers, potatoes, zinnias, salvia, chrysanthemums and roses.

Master Gardeners and youth volunteers maintain the gardens throughout the season, and Master Gardeners take growth and yield measurements at designated times. Results are compared across sites to help determine the effects of biochar, which was applied to all but each garden's control plot in the first year of the project. No additional biochar applications have been made, and no additional organic amendments have been used in order to gauge the effect of biochar as a stand-alone additive.

2014 was the third of four years that Master Gardeners will be involved in what is known as the CenUSA Bioenergy project. Led by Ken Moore at Iowa State University, the five-year project includes institutions in several states and is funded by the USDA National Institute for Food and Agriculture. The aim is to reduce U.S. dependence on foreign oil, as well as greenhouse gas emissions while increasing local renewable energy. (More information can be found at Iowa State's website: http://cenusa.iastate.edu/.)

Written by Lynne Davenport-Hagen, CenUSA Biochar Research and Display Garden project coordinator, and Julie Weisenhorn, associate extension professor at the University of Minnesota, the 2014 annual report shows mixed three-year results. While there were notable growth differences in some plants, others seemed unaffected by biochar. For example, chrysanthemums appeared more robust in plots amended with biochar while shrub roses showed no significant differences.

One of the things that does seem clear so far is that biochar appears to improve soil texture. Volunteers working in the wet spring soil reported that it was easier to plant in the amended plots than the control plots that contain no biochar. This was consistent across all of the sites, even though soil structure varies by location from sand to silt loam.

Variables to Consider

Each of the four demonstration gardens contain the same plants, as well as three plots: one with no biochar; one (TRT1) amended with 1/2 pound of biochar per square foot; and one (TRT2) amended with 1 pound of biochar per square foot. It appears that soil structure differences and other variables have had an effect on the data. For example, plants growing in the demonstration gardens at the University of Minnesota Landscape Arboretum and the University's St. Paul campus were clearly more vigorous than those at the Bunker Hills Park site in Andover, Minnesota, and at the Brookston Community Center, Fond du Lac Tribal Community site in Cloquet, Minnesota.

This is most likely due to the first two sites having silt loam soils that better hold moisture and nutrients than the sandy soil at the other two locations. Nutrient deficiency was also evident at the Andover and Fond du Lac sites, which also may be attributable to sandy soil conditions. At all sites, Master Gardener volunteers worked hard to keep diseases, weeds and pest problems under control. No pesticides have been used at any of the demonstration gardens.

Last year, responding to community needs, the Fond du Lac tribal community Extension Master Gardeners worked with staff at the Brookston Community Center to create a gardening education program for youth. As part of that, youth were invited to help care for the demonstration garden and collect data. Before long, the garden became the focus of a 20-week-long Junior Master Gardener program developed by the Fond du Lac Master Gardeners. Students have enjoyed this change in direction, but because it may affect the research, data from this garden was not collected in the same way it was at the other three Minnesota sites.

A Look At the Results

Since the project aims to determine whether biochar would make a good amendment for home gardens, guidelines for data collection are based on growers' recommended days-to-maturity. Using these optimal recommendations will make it more likely that data can be reasonably compared across sites.

About 35 Master Gardeners took data and recorded results in 2014, and though training was provided, it's important to note that there are some inaccuracies due to individual interpretations and opinions.

Also contributing to problems with data collection were last year's unusually cold, wet spring, as well as poor germination of some of the plants chosen for testing.

Tomatoes were the biggest surprise when it came to vegetables. Celebrity hybrid tomatoes in the control plots outperformed those growing in biochar-treated plots. This differs from 2013 data showing that tomatoes

did best in the TRT1 plots compared with the control and TRT2 plots. Because of this inconsistency, it's difficult to pinpoint whether biochar affects tomato productivity.

Basil appeared to grow better in TRT1 plots at Andover and the Arboretum. Overall, though, growth and yields were best in the TRT2 plots, particularly at the Andover site. Blue Lake bush beans did well in the TRT1 plots at Andover and the Arboretum, but yields were highest in the control plot on the St. Paul campus. This could be due to the plot's location, which provides a warmer microclimate that allowed the beans to mature faster than they did at other locations.

The hybrid cucumber, Tasty Green, was tested in all four gardens in 2014, but patterns of growth were inconsistent. So the effects of biochar on the crop could not be determined. The soil amendment's effect on the kale variety, Blue Curled Vates, also could not be determined. Black Seeded Simson lettuce and Sweet Treat carrots did not germinate well and both crops were considered a failure. No significant differences were noted between growth and yield of King Arthur hybrid bell peppers or the University of Minnesota's new potato variety, 'Runestone Gold'.

Data collected on ornamentals in the demonstration gardens included information on growth patterns, bloom and leaf color. 'Victoria' salvia and 'Uproar Rose' hybrid zinnia, for example, both showed better growth and leaf color in the biochar-amended plots at the Andover site. This may indicate biochar's ability to help sandy soil retain moisture and nutrients.

Similar data is collected on perennials and while 'Gold Country' chrysanthemums did not do well at any site, the varieties 'Betty Lou' and 'Maroon Pride' appeared to do somewhat better in TRT1 plots over others. Inconsistent growth patterns of three varieties of shrub roses made it unclear whether biochar had any effect on those plants. Overall, when comparing data over the past three years, there do not seem to be significant and consistent benefits in yields or growth when plants are grown using biochar as a soil amendment.

Going Forward

Master Gardener engagement with the biochar project has been beneficial in many ways with volunteers getting firsthand experience with data collection, as well as the opportunity to participate in a high-profile research endeavor. Because the demonstration gardens are visible to the public, the project has also created a welcome occasion for talking about biochar, and many other topics, with gardeners and others who are interested in things like plants, food, soil and sustainability. In this last year of the project, the goal is to gather the most reliable data possible. A new online reporting system has already increased reporting accuracy.

Also of note, in September, 2015, the Extension Master Gardener teams from Minnesota and Iowa will receive the International Master Gardener Search for Excellence Award for their work on the biochar project. The award will be presented at the International Master Gardener Conference in Council Bluffs, Iowa. Though testing biochar for possible use in home gardens is just one small part of the overall USDA-sponsored research project, the results will help determine under what conditions biochar could be recommended as a soil amendment. With one more year to conduct the research, the Master Gardeners hope to see more patterns and consistencies developing.

Redwood Forest Foundation (www.rffi.org/biochar.html)

September, 2015, Ukiah Daily Journal
The Redwood Forest Foundation's Biochar Demonstration Project has been in development over the past several years. It has the environmental benefit of utilizing the excess woody biomass found in the overcrowded forest stands in Mendocino County and converting it into a soil amendment that sequesters carbon and reduces water and fertilizer needs. According to project coordinator Judy Harwood, biochar provides jobs in the forest, in production, and in distribution and sales. The grant from the Community Foundation will purchase equipment needed to refine the chip drying process in order to make the system more economically viable.