

# Opportunities for biochar production and use in Florida citrus

By Arnold Schumann and Timothy Spann

**B**iochar is a solid material derived from the carbonization of organic matter — charcoal. It has been used as a soil amendment in agricultural production for centuries to improve soil structure and cation exchange capacity. Perhaps the best-known example of biochar use in agriculture is the “terra preta” (dark earth) soils of the Amazon. Scientists have found that these rich loam soils were created by pre-Columbian civilizations by incorporating charcoal and fish bones into the soil. The result is soil nine times more fertile than the surrounding unamended soil; the amended soil was capable of supporting agriculture to feed populations in the millions. Today biochar is receiving renewed interest in agriculture,

both for its soil-building properties and for its use in carbon sequestration to combat climate change.

## BIOCHAR PRODUCTION

As mentioned above, biochar is produced from organic matter — wood, leaves, manure, etc. — that is heated with little to no available oxygen and at relatively low temperature (<1,000 °F). This process, called pyrolysis, results in the thermochemi-



**Fig. 1.** Closeup of biochar soil aggregates and plant roots, which form mycorrhizal fungal associations

(Photo from <http://biocharfarms.org/farming/>, by Richard Haard)

cal decomposition of the organic matter. Unlike normal microbial decomposition of organic matter that produces water and carbon dioxide, pyrolysis of organic matter produces biochar and biogas; both processes also release mineral nutrients. The biogas is generally a mix of hydrogen, carbon monoxide and light hydrocarbons (methane, acetylene, ethylene, etc.), depending on the feedstock. These can be captured and used as fuel for heating or power generation. The biochar, which is virtually pure carbon, can then be used as an agricultural soil amendment.

## BIOCHAR AS A SOIL AMENDMENT

The carbon in biochar is highly resistant to decomposition and therefore can hold carbon in soils from hundreds to thousands of years. Thus, biochar can be viewed as a permanent addition to soils, making it particularly advantageous in perennial crop systems like citrus.

Biochar is naturally found in soils around the world as a result of vegetation fires as well as historical soil management practices (e.g., terra preta soils). Biochar can be an important tool in areas with highly depleted soils, scarce organic resource availability, or inadequate water and/or chemical fertilizer supplies. In highly depleted or leaching-prone soils, biochar can be an important tool for preventing groundwater contamination by increasing soil retention of fertilizer nutrients and agrochemicals. Biochar itself is not a fertilizer; it is a stable form of carbon and a permanent soil amendment.

One of biochar’s important effects on soil comes through improving the number and diversity of beneficial soil

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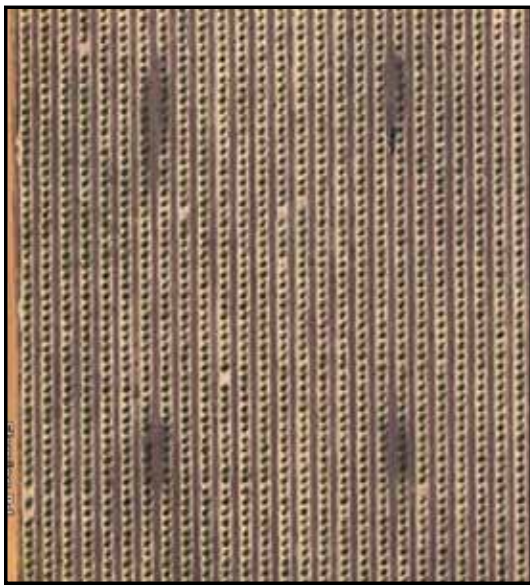
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microbes (Fig. 1, page 6). The fine porous structure of biochar serves as a habitat for microbes, protecting them from drought and predation as well as providing for some of their carbon, energy and mineral needs. Understanding specifically how biochar affects the soil ecology is a very active area of research.

Biochar has a negative charge, which allows it to buffer soil pH. In addition, the negative charge gives biochar a high cation exchange capacity (CEC), allowing it to hold plant nutrients in the soil. Cations are positively charged ions, with calcium ( $\text{Ca}^{2+}$ ), potassium ( $\text{K}^+$ ) and magnesium ( $\text{Mg}^{2+}$ ), among others, being particularly important to agriculture.

**Fig. 2 (above).** Aerial view of a portion of a citrus grove showing the effects of four burn piles on tree growth (Photo from Google Earth)

**Fig. 3 (right).** Close-up view of individual trees in the grove shown in Figure 2. The tree on the left is growing on the burn pile-amended soil and the tree on the right is growing in the unamended soil (note the 5-gallon bucket for scale). The images of the soil samples show the difference in soil color and other characteristics.



These basic forms of mineral nutrients are those that plants take up through their roots. Soils high in organic matter or clay content have naturally high CECs and retain mineral nutrients well, making them available to plants as they are needed. However, highly leached sandy soils like those throughout much of Florida have very low CEC, and mineral nutrients can be easily leached with rain or irrigation water.

Although biochar itself does not contain any appreciable amounts of nutrients, its addition to poor soils can greatly enhance their nutrient-holding capacity and potentially reduce fertilizer inputs. Cited benefits of biochar on soil properties include a 50 percent increase in CEC, a 10 percent to 30 percent increase in fertilizer efficiency, 18 percent higher soil moisture retention, 20 percent to 120 percent increased crop productivity, 40 percent increase in beneficial mycorrhizal fungi, and a 50 percent to 72 percent increase in biological nitrogen fixation. Biochar has also been tested for remediating toxic chemicals in contaminated soils, and one study reported a tenfold reduction of cadmium in soil after application of biochar, with subsequent reduction of phytotoxicity.

### SOIL AMENDMENT IN FLORIDA CITRUS

Florida citrus soils can be highly variable. In an article published in the April 2010 issue of *Citrus Industry* ("Citrus Tree Health and HLB Incidence," page 14), we presented data on how very small changes in soil composition, particularly organic matter, can have huge impacts on tree growth, productivity and health. A more in-depth presentation of these data was recently published and is available on the EDIS website (<http://edis.ifas.ufl.edu/pdffiles/SS/SS55700.pdf>). In addition to demonstrating the potentially huge benefits from amending our poor soils, these data show that such amendments are not required over an entire grove, but only on the weakest soils. Targeting amendment efforts at the weakest areas makes soil amendment an affordable management tool.

### BURN PILES: POTENTIAL BENEFITS FROM BIOCHAR AMENDMENTS TO CITRUS SOILS

Many growers have observed the effects of burn piles on subsequent citrus growth. Initially the transplanted trees may perform poorly on burn-pile locations, and then after some months or years, the trend may reverse and they grow exceptionally well thereafter. Burn piles actually produce mostly ash from aerobic combustion, and very

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little biochar. The ash tends to oversupply nutrients and especially alkalinity, thus stunting initial growth until the excess soluble components are weathered and leached from the soil, leaving mostly the insoluble biochar.

We have been collecting data to understand the growth differences of 4-year-old citrus trees growing on burn pile-affected soil and surrounding unaffected soil (Fig. 2, page 8). The trees that grew on the dark carbon-enriched soil had 67 percent more canopy volume than trees in adjacent unamended soil (Fig. 3, page 8). The soil carbon, measured by loss-on-ignition (LOI), and the CEC were 4.5 times higher in the burn-pile area, compared to the native soil levels. Also, extractable soil copper concentration in the grove soil was high (139 lb./acre), but was reduced to negligible levels (0.4 lb./acre) in the burn pile, biochar-amended soil.

More research is needed to fully understand the burn-pile phenomenon, but, more importantly, studies testing the effects of biochar sources, rates and application methods on citrus are required to develop reliable recommendations for Florida. Ideally, biochar should be produced on location with citrus trees removed from groves, thus reducing the high cost of transporting a bulky material. Biochar yield from citrus trees would depend on the standing biomass in the grove, probably in the range of a few tons per acre.

Currently, the Florida citrus industry can be considered carbon positive because the trees are ultimately burned. That is, the carbon dioxide released to the atmosphere during the growing and then burning of the trees exceeds the carbon dioxide that is sequestered by the trees through photosynthesis and biomass storage. The conversion of dead trees to biochar can permanently improve our citrus soils for better production and store carbon long-term. In so doing, the Florida citrus industry could become carbon neutral or even carbon negative (a process that removes carbon dioxide from Earth's atmosphere).

Biochar is a soil amendment with proven benefits to many crops, including citrus, based on observations of tree growth in burn pile-affected soil. Biochar improves nutrient retention and soil structure, leading to improved crop productivity and health. And all of these benefits can be obtained from locally produced biochar made from normal agricultural waste material.

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## FDOC Increases Orange Juice Marketing Activities

By Douglas Ackerman



The Florida Department of Citrus (FDOC) strives to maintain market share for Florida citrus in spite of ongoing, external challenges including slow economic recovery, higher prices, increased competition from other beverages and reduced promotional activity. This year, we are also combating negative news, which has created consumer confusion about the safety of orange juice. Ensuring quality and safety of Florida citrus has always been, and will continue to be, a priority of the citrus industry. FDOC is committed to promoting our great Florida citrus products and ensuring that orange juice remains relevant to today's consumer.

The Florida Citrus Commission, in support of FDOC's leadership role as the marketing agency for the Florida citrus industry, provided an additional \$2 million to increase current domestic marketing activities and reinforce positive messages about Florida orange juice. This increase was funded by a cost savings of \$1.5 million that will not be used for disease research this fiscal year, as well as uncommitted reserves.

In addition to the fully integrated 2011-2012 marketing plan already under way, the FDOC marketing team identified new areas of opportunity to surround consumers with messages about Florida orange juice throughout their day via traditional and social media channels.

A 15-second TV commercial launched in early March features the eye-catching visual of orange juice pouring into a glass. The script emphasizes the pure, natural goodness of delicious, 100 percent Florida orange juice. You can view the commercial at <http://www.floridajuce.com/videos.php>. With this increased budget, we've purchased three additional weeks of television to increase consumer reach and frequency.

Because our target customers spend a great deal of time online, we've secured partnerships with trusted, influential websites to provide nutrition-related information, interactive content and recipes on WebMD.com, LadiesHomeJournal.com, FitnessMagazine.com and EatingWell.com.

Florida orange juice banner ads will break through the clutter and gain attention on other strategically targeted websites including Women's Health, Men's Health, Shape, Self, Food Network and All Recipes.

Innovative social media applications allow us to reach consumers in new ways, such as a Florida orange juice mood board on the hot, new Pinterest site and an interactive Twitter party.

All marketing activities drive traffic to our Florida orange juice Facebook page where we deliver positive, robust information and reinforce the value of orange juice.

Incremental marketing activities will be carefully monitored and measured to determine their ability to influence consumer attitudes, consumption intent and purchases. Results will help strengthen the marketing program currently under development for fiscal year 2012-2013. Our goal is to ensure that orange juice remains a staple in nearly 70 percent of American households and consumers continue to take on the day with a daily glass of Florida orange juice.

*The mission of the Florida Department of Citrus is to grow the market for the Florida citrus industry to enhance the economic well-being of the Florida citrus grower, citrus industry and the state of Florida. Douglas Ackerman, executive director, can be reached at (863) 537-3999. For more information, visit [www.FDOCgrower.com](http://www.FDOCgrower.com)*



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