BIOCHAR INCREASES PLANT SURVIVAL

Concerns about the high cost of growing media, recent supply chain issues, and unease about the environmental impacts of peat have spurred interest in alternative media for the horticultural and turf industries. Biochar offers the potential of a natural, local, and sustainably sourced alternative to peat and other common growing ingredients including vermiculite and perlite. Research shows that certain types of biochar can be a cost-effective replacement for growing media and potting additives like perlite[1], clay granules, Sphagnum peat[2], and vermiculite. Studies using biochar on greenhouse plants such as lettuce, sunflowers, and marigolds resulted in equal or better performance. In one study involving tree seedlings, wood biochar effectively replaced peat with varying results based on the form of biochar[3] (powder, pelletized, or bulk).

Biochar from different feedstocks and temperature regimes behaves differently depending on the applications. Research has shown that some types of wood biochar can effectively replace peat[4]. However, biochar particle size, total extractable nutrients and pH levels make a difference. Biochar made from bark has a different nutrient content than biochar made from leaves and branches. In general, care should be taken to sift out the fine fraction (<1 mm) and conduct a pH and nutrient analysis before using the material as a growing media.

The core attributes of biochar as a replacement for existing growing media (be it horticulture, green roofs, or golf course turf) are:

1. **Bulking agent: medium size (2 mm to 6 mm)**
2. **Hydrophilic: ability to retain moisture**
3. **Low in nutrients like NPK**

Economic benefits

- **Increase plant survival:** Increase plant survival: Certain types of biochar have shown an increase in water holding capacity when used as an amendment in soil mixes[5]. With increasing swings in climate, biochar medias can provide plants with more available water which can reduce their mortality.
- **Boost in yields:** Biochar amended soil mixes boost yields in certain crops and conditions, particularly in sandy soils during hot summers. Increases in yields were shown in studies of blueberries[6] and in lab tests of wheat, barley, and maize[7].
- **Carbon credit markets:** Biochar has been shown to be valued in the carbon market (see our other fact sheet on “biochar and carbon markets” for details). Adding biochar to soil media, or compost or directly to soil can generate carbon benefits.

  Currently, voluntary carbon buyers are paying about $200 per ton, for the carbon benefits of biochar. Using biochar can be a potential new source of revenue for greenhouse operators and soil mixing businesses.

How to use biochar in growing medias

As many have said, "Not all biochar is created the same." In general, biochar specification varies by crop and media requirements.

Given all these variables, potential users of biochar or those that are selling biochar as a growing media should consult with their local biochar producer or their local horticulturalist at a nearby university.

Application	Benefits by	General size guideline	Desirable biochar qualities
Tree seedlings	Holding onto H_20, preventing plantings from drying out in summer heat	½" minus, some fines ok (and desirable)	Inoculate first (mix with something before application, organic nutrients)
Green roof media	Exporting nutrients in runoff, increasing plant survival during summer	½" preferred. Some fines acceptable	Light aggregate, holds water, provides biology and structure for the plants
Veggies and seedlings	Enhancing soil biology, replacing peat which is environmentally damaging, boosting yields	¼" minus (3 mesh).	Inoculate first (mix with something before application, organic nutrients). Adds organic carbon, holds H20, boosts yields.
Golf greens and turf	Enhancing soil biology, reduce H20 use	Powder size for spraying as a slurry on golf greens and tees	Inoculate biochar first so that it doesn't soak up nutrients in first years of application.

CASE HISTORY: MISSOURI ORGANIC RECYCLING

CHALLENGE/OPPORTUNITY: Founded in 1992, Missouri Organic Recycling provides soil blends and compost products to their customers. Since 2008, they've diverted more than 150 million pounds of food waste from landfills and turned them into valuable compost products for farmers and growers in the region.

Stan Slaughter, an Education and Garden Specialist for Missouri Organic Recycling (based in Kansas City, MO), specializes in creating value-added soil blends using low-value ingredients (food waste, leaves, urban tree cuttings, and other waste biomass) and converting them into high-value organic soil amendments.

In 2019, Stan heard about biochar as a promising soil organic matter additive that could sequester carbon and provide a more nutrient rich soil product. He was particularly interested in biochar's ability to act as a "condominium to hold onto nutrients and water" compared to compost.

SOLUTION/APPROACH: To explore biochar as a potential soil blend ingredient, Stan worked with Dave Yarrow and Phil Bloom and ran different tests of biochar amended soil blends. After a couple of years of testing

and development, Missouri Organic Recycling began using biochar as an amendment in their compost and soil blend products, creating a new biochar-based product called "Green Frontier Compost."

RESULTS: The company notes that customers like the biochar-amended products for two main reasons: the biochar increases soil moisture helping new plants survive in the summer heat and it increases yields. One customer said of the biochar product, "We are proud to have it on our shelves. As our customer base expands into more diverse growing needs, we find that it fits the bill for whatever they are growing."

CONCLUSION: Missouri Organic Recycling anticipates growth in their biochar product lines as they increase the supply of high quality biochar ingredients. Regarding biochar supplies, Stan said "The biochar market is decent. We have enough demand to move a truckload of biochar today, but I need better supply volumes to grow the market. Then, we can turn the demand for biochar into a flood".

CASE HISTORY: DR. BRYAN MANN, VICTORY GARDENS

CHALLENGE/OPPORTUNITY: Dr. Bryan Mann owns and operates a small specialty crop vegetable farm near Maiz, Kansas. His company, named "Victory Gardens," symbolizes his passion for sustainable farming. Since starting his business in the late 2000's, Mann has grown nutrient dense produce with a minimal carbon footprint.

"We spend a lot of time trying to build our soil out here. If you have healthy soil, you are far less likely to have to use chemicals and other inputs from unsustainable sources (petroleum-based products)," Mann said. "I believe in sustainable farming. I truly do. It is the future of agriculture. We can't keep cultivating farmland with fertilizers and chemicals."

In addition, Mann said "with climate change impacts increasing, we are seeing longer, drier summers that really stress crops. My biochar and compost amended beds can hold onto moisture, and I've shown that I can still produce quality tomatoes even in very hot summers."

"Specialty crop vegetable farms are in a unique position to have a collective influence on carbon sequestration in the USA," he continued. "Over 74,000 vegetable farms exist in the USA and account for approximately 4 million acres."

SOLUTION/APPROACH: Many of Kansas' soils are dry and heavy in clay. Mann found that by using different composting techniques and Hugel tunnels combined with biochar, he can grow high quality crops on his farm, including nutrient dense crops even during summer drought conditions.

Mann has been using biochar for about the last 10 years. He makes his biochar with different scrap wood and other feedstocks from around his farm. He adds biochar as a layer to the top of Hugel beds until the top is completely covered with biochar.

RESULTS: Mann grows his crops with all natural ingredients, and that do not include any fertilizers or herbicides. His margins for growing specialty crops are good compared to other farmers in the region.

CONCLUSION: Demand for high quality produce remains strong and sales increase every year. Mann's commitment to sustainable and regenerative techniques are important to his customers. With the impacts of hot dry summers increasing, using biochar provides a welcome way to mitigate extreme weather events and avoid crop losses.

Non-economic benefits

Made from a variety of biogenic biomass sources (leaves, wood chips, agricultural residues, orchard pruning, vineyard cuttings, and many others), biochar feedstocks are natural and renewable.

Many locations across the United States have excess biomass with little or no market value. These materials are often either burned or sent to a landfill. Biochar applications like in soil blends and amendments provide a valuable mechanism to divert large-scale waste biomass resources and make them into something that can increase crop survival and yields.

CASE HISTORY: NORTH SHORE COUNTRY CLUB

Challenge/Opportunity: Dan Dinelli, CGCS, golf course superintendent at North Shore Country Club, wanted to find a product to replace peat in the rootzone on the greens. He chose to use biochar, because it sequesters carbon and stays intact for hundreds of years, while a high percent of peat will degrade. This benefits the long-term function[8] and sustainability of a putting green.

Solution/Approach: Biochar was pretreated with nutrients, bio-stimulants, carbon sources, and pH modifiers and then set aside to allow for the amendments to absorb. It was also inoculated with microorganisms, stored in a dark, warm room, and stirred periodically. The biochar for each treatment was mixed with USGA recommended rootzone sand at a ratio of 9:1 to represent a rootzone that was 90% sand 10% biochar V/V. The sand/biochar mixes were then packed into PVC cylinders at a 12" depth on top of 4" of pea gravel to simulate a USGA recommended rootzone for a green. The turf was watered and cut two to three times a week and fertilized once.

Results: On his course, Dinelli found that quality, pre-conditioned biochar added value in several areas:

- **Water retention**
- **Nutrient holding due to biochar's high CEC**
- **Soil and plant health was enhanced through microbial activity**

Conclusion: Dinelli is very pleased with the sand/biochar he uses and believes other golf courses would see similar results. Yet, he cautions that more research is needed to set standards that would allow other courses to replicate his results without doing the studies that he did.

Reference Guide

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