"It is impossible to contemplate the life of the soil for very long without seeing it as analogous to the life of the spirit." Wendell Berry

Agriculture Resiliency

Biochar

Snohomish Conservation District

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BIOCHAR

In the 1950's, a Dutch soil scientist discovered terra preta, or black earth, in the soils of ancient Amazonia. It was discovered that this black earth had been created by humans through a traditional agricultural practice that had been used in the Amazon for over 2,500 years. Farmers would bury and burn biomass creating biochar within soil profiles, thus endowing otherwise poor jungle soils with properties that were essential for the cultivation of food crops.. This ancient practice has since been discovered to cover approximately 10% or the Amazon basin and has been discovered around the world in areas including Ecuador, Peru, Liberia, and parts of West Africa (USBI, 2018).

Similar soils have been created by naturally occurring wildfire regimes over thousands of years. The Mollisol soils of the Midwestern plains of the United States and the Chernozem soils of the Russian steppe are a result of this process (Schahczenski, 2018).

What is Biochar?

Biochar is essentially charcoal. Traditionally it has been produced by piling wood, covering it with earth and allowing it to slowly burn in a limited air environment. This method is still widely used today in many countries, however, it releases a large amount of the carbon in the biomass (about half) into the atmosphere. A more efficient way of producing biochar is through the process of pyrolysis - a method of combustion in the near or complete absence of oxygen. In addition to biochar, this process also creates gasses and bio-oils that have potential for fuel use (USBI, 2018).

Benefits

As a soil amendment, biochar shows potential to improve soil physical properties, enhance fertility, and reduce economic costs by reducing the need for fertilizers. Research is ongoing into the mechanisms for how biochar provides fertility to crops, but a few initial studies show promise for using biochar to increase fertility and yields in degraded or acidic soils. Potential benefits of biochar for soil health include:

- Attracts and holds moisture – potentially reducing irrigation needs
- Attracts and holds nutrients - reducing nitrate leaching and overall fertilizer needs
- Increases nutrient availability – extensive pore structure creates habitat for beneficial microorganisms that break down organic matter
- Remains persistent in soils – resilient to chemical and microbial degradation
- Reduces soil acidity – reducing the need for lime
- Absorbs gasses - reducing carbon dioxide and nitrous oxide emissions from soils
- Enhances crop yields

Biochar Does Not Work Alone!

Biochar is not a fertilizer in and of itself, but a soil amendment that can be a catalyst for many soil health benefits. The effectiveness of biochar is through synergies that form between the organic matter inputs, living root systems, and soil organisms.. For example, when biochar is mixed with dairy manure and used as an amendment, soil water holding capacity increases to a greater degree than would be realized through the application of either amendment alone (Schahczenski, 2018).

Economic Potential for On-Farm Use

In addition to increased yields, biochar offers possible economic benefit for farms in three main ways:

- As a soil amendment it increases soil health and decreases fertilizer inputs and irrigation needs
- If produced on farm it has the potential to offer bio-oils and gasses for farm energy use
- There is potential for biochar to be a carbon off-set in future cap-and-trade markets

Biochar is not a silver bullet. It can bind nutrients in the first year after application and potentially decrease yields. In years 2-3, benefits should begin to be realized, especially if biochar is combined with manure or compost. While this amendment can realize many benefits for soils and crop yields, it can be expensive and should be viewed as one of many tools including compost, crop residue, cover crops, and mulches.

Local Research

The Seattle based SeaChar organization conducted local scientific field trial of biochar in 2010 to determine its effectiveness on Pacific Northwest soils. The trial consisted of three plots - one control, one treated with biochar, and one treated with a biochar/compost mix. The study tested biochar's effects on soil organic carbon, pH, crop biomass and nitrogen uptake, as well as plant available nutrients. Conclusions from the trial found that soil carbon and pH increased on both of the treated plots. Plant available Mg increased while Zn and Cu were found to be adsorbed by the biochar and less available to plants. This did not affect plant growth as levels of Zn and Cu were high enough in the soils to be readily available to plants regardless of the amounts adsorbed by the biochar. Plant biomass was not found to have increased significantly over a 1 year soil treatment period, however this is expected as the benefits of biochar are not usually fully realized until the 2nd or 3rd year. Results, however, point to the potential benefits that could be realized over time.

For more information the study can be found at the following link: https://www.biochar-journal.org/en/ct/62

How to Use Biochar

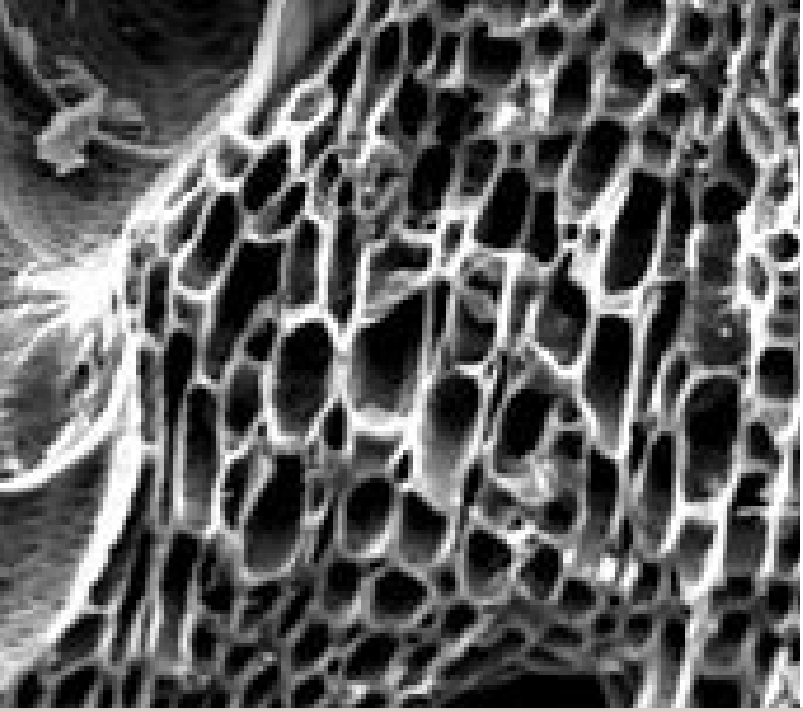
Due to differences in biochar based on feedstocks and the pyrolysis process used, different sources of biochar will behave differently in soils. For example, biochar made from manure will be higher in nutrients, lower in carbon, and will break down faster in soils. Biochar made from wood will have more carbon and be more resilient, lasting in soils for many years. The effectiveness of biochar increases over time as it becomes more porous due to weathering. The International Biochar Initiative (IBI) has developed product standards and testing guidelines for biochar to be used in soil amendments. Information on product standards and certification are on the IBI website: http://www.biochar-international.org/certification

Experimenting with small plots of land and monitoring the effects on your soils might be a good idea before applying on a broad scale. Researching the availability of feedstocks and types of biochar depending on what benefits you are looking for will be necessary.

Experiments have found that rates ranging between 5 to 50 tons/acre are successful in realizing many of the soil health benefits mentioned above (IBI, 2018). The University of Massachusetts (2012) and Biomass Magazine (2018) both quote the cost of biochar to be around $200/ton. While this can be costly, one way to begin incorporating biochar more minimally is by direct row application either before or during planting. A 40lb bag will inoculate about 45 linear feet within a row.

In addition to soil health benefits, biochar can be used to absorb nutrients and be re-applied to crops. It also has uses as a mitigation tool for excess nutrient runoff. For example, it has been used to absorb ammonia from animal bedding from poultry facilities or can be combined with diary or horse manure to be used on crop fields as a rich fertilizer. Biochar has also been applied to drainage ditches on dairy farms to reduce fecal coliform and phosphate runoff (Living Web Farms, 2013).

The Pacific Northwest Biochar Atlas has a biochar selection tool that can assist you with selecting the correct source of biochar for your soil types and your production goals. http://www.pnwbiochar.org/tools/selector/



Find Out More

ATTRA Biochar and Sustainable Agriculture Publication
- https://snocd.org/attra-biochar

Black Owl Biochar Everson, WA
- https://www.biocharsupreme.com/

International Biochar Initiative Newsletter
- http://www.biochar-international.org/newsletter

Pacific Northwest Biochar Atlas
- http://www.pnwbiochar.org/tools/selector/

TEDxHilo - Josiah Hunt - Biochar and the Future of Farming 2012
- https://snocd.org/future-biochar

References

Granastein, D., C. Kruger, H. Collins, M. Garcia-Perez, and J. Yoder. 2009. Final Report: Use of Biochar from the Pyrolysis of Waste Organic Material as a Soil Amendment. Ecology Publication Number 09-07-062. Center for Sustaining Agriculture and Natural Resources. Washington State University.

International Biochar Initiative (IBI). 2018. Biochar Use in Soils. http://www.biochar-international.org/biochar/soils

Ippolito, J., A. Donnelly, J. Grob. 2015. Anatomy of a Field Trial – Wood-based Biochar and Compost Influences a Pacific Northwest Soil. The Biochar Journal. Arbaz, Switzerland. ISSN 2297-1114. pp 34-43. https://www.biochar-journal.org/en/ct/62

Living Web Farms. 2013. Biochar Workshop Videos. https://www.bing.com/videos/