



Understanding Biochar Series

Guidance On The Application Of Biochar To Growing Systems

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Recommended background reading: Chapter 7 of “The Biochar Revolution”, Paul Taylor, Ed.

Biochar is a variable material, depending on the source and quality, and growing systems (plant/soil/climate combinations) come in infinite combinations. As such, this guidance is just that – guidance – and subject to the local insights and skills of the grower. In addition, biochar works in conjunction with the rest of the soil attributes, and does best when fixing something that is correctible, like too sandy (excess drainage and poor moisture retention) or too much clay (poor aeration and turns rock hard when dried out). For soils without pronounced flaws, biochar make the soil better at providing the functions of the soil, like moisture capture, nutrient retention and providing a host of microbial partners to work with the plant to their mutual benefit.

One observation about “organic” growing systems, where supplemental plant nutrients, if any, typically take the form of composted and recycled biota, versus chemical fertilization, where inorganic forms of NPK are supplied to directly feed the plants: Biochar is more effective in the “non-chemical” approach. This is because chemical fertilizers inhibit the role of the plant feeding root exudates to the soil microbes in exchange for plant nutrients. In the “organic” approach, one gets both the modification of the soil physical properties, like water retention, and the enhanced biological health of the soil. In the chemical fertilization approach, one still gets the modified soil mechanics, but the microbial benefits are inhibited or even eliminated.

The starting point introducing biochar into a growing system is the biochar itself – which brings up the issue of **Quality**. Quality is a very poorly understood concept in the biochar community,

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and I will just scratch the surface here. The first observation is “save a sample” of whatever you are adding to your soil, either the pure biochar or the biochar/compost/etc mix. Seal a pint jar of material and stow it away for future reference – to help sort out any questions about why something didn’t work, or perhaps why something went extra right. If everything works great, put the material in next year’s garden.

If you are adding a biochar/compost/etc mix, it is pretty hard to tell a lot about the quality of the original biochar. Many blends feature biochar that has been passed through a composting process, and this approach is highly recommended. Any biochar will benefit from being composted, as discussed further in UB#5, and any compost process will likely benefit from having biochar present while breaking down the excess organic matter. So, if you buy pure biochar, consider your options for passing it through a composting process before addition to the soil.

In the case of pure biochar, there are several things to look for right away. The first is **odor** – or the fact that there should be NONE. Quality biochar does not smell like smoke or campfires or anything. Biochar adsorbs odors – it does not give them off. The second issue is how much moisture is present. Biochar is a material that works in the soil mostly as a volume of material, and does not swell or shrink depending on how much water it holds. However, if the biochar is being sold by weight, you are paying as much for the water as the biochar – so watch out. At the end of the day, you will be adding 5 to 10 volume percent biochar to the root zone of the soil. Biochar can hold several times its dry weight in water, so it takes a large weight of wet biochar to fill the same volume of dry biochar. It is a lot cheaper to add water after you buy the biochar, not as part of the initial purchase.

The last issue for biochar is the impact the ash will have on the soil. All biochars have a portion of ash, depending on the starting material and way the biomass is converted to biochar. Some industrial processes generate a “high-carbon ash”, which often gets morphed over into marketable biochar by the supplier as it is repackaged unchanged and renamed. Unfortunately, the International Biochar Initiative certification standard is essentially worthless



at protecting the buyer from excess ash levels, requiring only a declaration of the ash level and allowing potentially 90 weight percent ash to still be a certified biochar, with biochars with up to 30 weight percent ash being “Class 1”, the highest ranking. One quick test is to add a small portion of biochar to an excess of clean water, and taste the water after the char wets out. The absence of a strong taste, like the absence of odor, is the best sign, although it is likely that there will be a taste of some sort.

There are a few tips to give the biochar its best chance of providing the most benefit to the soil and plants. As discussed above, passing the biochar through a composting process is a very good and safe way of removing any characteristics of the biochar that might slow the subsequent plant growth in the soil mixture. Needless to say, if you add the biochar to the front end of the composting process and the composting does not proceed as expected, that is a caution flag. Composting is a microbial process, and inhibiting the composting process means the biochar has some characteristic that is not compatible with the microbes. In general, good biochar should accelerate the composting process, making it hotter and faster, because the biochar is benefiting the composting microbes in the same manner it will be benefiting the soil microbes.

The amount of biochar that should be added to the soil, and how the biochar is added, vary depending on the intended benefit. In general, the benefits are linear up to about 10 volume percent, and additional biochar has diminishing benefits. If the biochar is being added to improve soil aeration, such as for high clay soils, then the biochar should be tilled into the entire soil root zone. For most other benefits, including addition to sandy soils, the biochar can be top-dressed and blended with the upper soil. Over time, the biochar will migrate into the entire root zone. For 5 volume percent, a one-quarter inch deep layer of biochar is worked into the soil, assuming the root zone is 5 inches deep. 10 volume percent equates to a starting with a one half inch layer and blending it in. Overtime, the biochar will be incorporated into the soil aggregates, especially if the soil has significant microbial activity, as in organic growing systems. A good rule of thumb is one quart of biochar per square foot of soil, so a gallon does four square feet and a cubic foot of biochar will cover 30 square feet.



One issue that often comes up is the size of the biochar particles. In general, smaller particles are better, but the biochar will also breakdown to smaller sizes over time in the soil. Introducing dry powdered biochar is dusty work and has the risk that the biochar will blow away from the top of the soil. All biochars should be wetted sufficiently to avoid the dust problem, both for the lungs of the grower and to avoid losing biochar from where it is applied. In climates with freezing temperatures in the winter, the biochar will break down naturally as the water freezes and breaks the char apart. The rule of thumb is anything over ¼ inch should be crushed unless it will freeze next winter, and anything less than 1/16th of an inch is already fine enough.

As a final note, biochar that is made from clean agricultural residues, such as woody material, leaves and grass stalks, is generally very safe for introduction into the soil if it does not have an odor, meaning it was heated to a high enough temperature to convert the biomass to stable carbon, and has relatively low ash, meaning all the stable carbon was not burned out of the char. Excess ash tends to appear as a gray dust – good biochar will show virtually none of that.

Biochar should and will ultimately be an intentional material, not a byproduct of some random industrial process like a biomass gasifier or a fast-pyrolysis process. The desirable qualities allow the biochar to have maximum efficacy in benefiting the growing system and that benefit will last for a very long time in the soil. As such, doing it right the first time makes perfect sense to the party using and benefiting from biochar, which is the grower.



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