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UTAH PESTS QUARTERLY

NEWSLETTER

Utah Plant Pest Diagnostic Laboratory

USU Extension

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Is Biochar Worth it for Utah's Vegetable Producers?

Biochar is made by burning biomass at very high temperatures with low oxygen. The final product is high in carbon and is used as a soil amendment.

Biochar has been shown to have long-term benefits for the environment, in terms of sequestering carbon in the soil. But for intensive agricultural production, the short answer to this question is that biochar is not quite ready for wide-scale adoption. Some factors that need to be considered in applying biochar to the soil are initial soil health, the source and production method of the char, and the variable or unknown application rates. In some cases, crop yield may be marginally increased, but this benefit might not outweigh the cost of the biochar itself. Recent studies in the West, including one by USU Extension, have shown mixed results for certain biochar effects vegetable crops.

What is Biochar?

Biochar is similar to charcoal, but instead, it is produced in a controlled environment. Biomass (the "feedstock") in the form of wood or crop residue, manure, paper mill waste, etc., is burned at a very high temperature (350 – 900°C) under low oxygen, in a process called pyrolysis. The resulting product is of varying particle size, comprising about 50-75% carbon.

What are the Potential Advantages in Agriculture?

Most biochars have low nitrogen concentrations and thus any inherent fertilizer value is minimal and temporary. The recommendation is that biochar is applied to the soil just once, acting as a conditioner, and that nutrient amendments should also be applied yearly (if needed). Some research studies have found the following benefits of a one-time biochar application on agricultural soils (resulting in improved plant growth and crop yield):

- greater soil nutrient retention due to enhanced cation exchange capacity
- improved efficacy of fertilizers
- higher soil water retention
- increased soil pH
- increased soil aeration
- increased beneficial soil microorganisms
- greater earthworm populations due to improved soil conditions

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Biochar and fertilizer applied to a vegetable plot in Utah.

What are the Limitations in Agriculture?

- *Initial soil health:* When biochar research started flourishing, results from tropical systems were very positive, and the excitement in biochar grew. However, those same benefits did not always translate to western U.S. temperate soils and crops. In fact, plants growing in soils that are already healthy may not benefit at all from a biochar application. As one example, a recent study published by the University of California-Davis showed that after three years, there were no long-term benefits in biochar application on a tomato-corn rotational cropping system (Griffen et al. 2016).
- *Source and production method:* Properties of biochar vary with both the feedstock from which it is produced and the method of production. And in turn, these different biochars will behave differently in soils. Although one type of char may show promise, another type may not. Because of this, people are realizing the importance of "classifying" different biochar types based on their properties and potential crop benefits.
- *Application rate:* In soil application, biochar is persistent, and may improve soil condition over time. But specific crop application rates have not been determined. Research studies of biochar in agriculture have used one-time rates ranging from 2 to 22 tons per acre. Higher rates appear to have a diminishing effect. The need for further clarity on optimizing biochar application for increased crop yields is necessary if it is to gain widespread adoption as a soil amendment.
- *Cost:* Today, purchasing commercially-prepared biochar for agriculture is not economically feasible. The cost ranges from $400 to $2,000 per ton (and $100 – 300/cubic yard). Scaling the rate down for backyard gardens results in a slightly more acceptable cost, with bagged products ranging from about $25 - $40 per cubic foot (covering 100 - 350 square feet). As an alternative, some commercial growers are investigating on-site production of their own biochar:
    - Learn to Make Charcoal at restorechar.org
    - Kiln Design Resources

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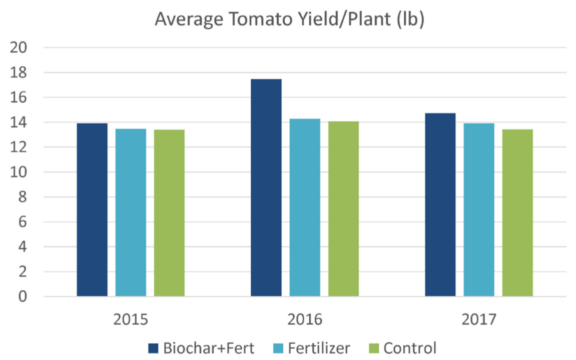
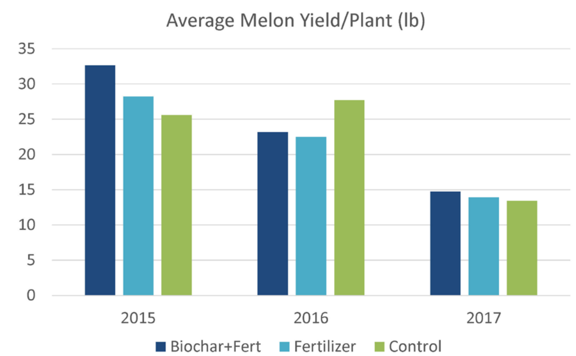
USU Extension Biochar Study

Over a period of three years, USU Extension investigated whether biochar as a soil amendment would improve crop yield and root rot-resistance of tomato and melon. For **crop-yield comparisons**, biochar (from beetle-killed pine pyrolized at 375°C) was soil-applied in 2015 at a rate of 10 tons/acre at the USU Experimental Research Farm in Kaysville. Each year, we compared tomato and melon fruit yields after a season grown in either biochar+fertilizer, fertilizer, or no amendment. There was no statistical improvement in yield from the biochar + fertilizer application; however, there were trends in the results:



- For the tomatoes in all three years, both average dry weight per plant and yield was highest in the biochar plots, with the greatest increase for both measures in year two.



- For the melons, both the average dry weight per plant and yield was highest in the biochar plot in the first year, but the increase in yield did not continue. In year 2, dry weight was again highest again in the biochar plots, with yield second highest. By year 3, yield was lowest in the biochar plots, and dry weight was highest in the control plots, followed by the biochar plots.

The **root rot-resistance comparison** was conducted in a greenhouse where we grew tomato and melon transplants in potting soil that was either amended or not amended with the same type of biochar (2% rate by volume). After approximately 6 weeks of growth, half the potted plants were each inoculated with 20 rice grains coated in mycelium of a mix of *Phytophthora capsici*, *P. nicotianae*, *P. cactorum*, and *P. megasperma*. Plants were then grown with normal irrigation and fertilization for an additional 8 weeks. Plants were then rated for disease, weighed, and roots were tested for *Phytophthora* with Agdia test kits. Disease was found on the inoculated plants in both soil types, and no disease was found on un-inoculated plants. This trial was repeated three times. We had hoped to see less incidence of disease on plants growing in the biochar soils, but instead, we found that:

- For both the melons and tomatoes that were inoculated with *Phytophthora*, there were no differences in the number of diseased plants, symptoms (based on individual plant ratings), or average dry plant weight, between the plants growing in biochar and non-biochar media.

Biochar is still a hot topic, as the number of biochar-related scholarly publications have increased nearly five-fold over the last five years. Indications suggest that biochar could play a role in improving sustainable agriculture. But the challenges of cost, variability in biochar types and application rates, and how this technique can work with other soil health practices such as no-till, cover cropping, manuring, and mulching, still need to be addressed. Certainly, improved recommendations for agriculture and landscape industries and residential sites are coming, but a few years down the road.

Land reclamation is an area of potential use for biochar that may be more productive than use in commercial agriculture. Research scientist Chris Peltz and USU Forestry Extension Associate Darren McAvoy are interested in using biochar as a tool for land reclamation in the Uinta Basin. Learn more about this here.

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References

Griffin, Deirdre E., Wang, Daoyuan, Parikh, Sanjai J., Scow, Kate M., 2016. Short-lived effects of walnut shell biochar on soils and crop yields in a long-term field experiment. Agricultural, Ecosystems & Environment, Vol. 236, 2 January 2017, Pages 21-29.

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