Center for Native Grasslands Management

USE OF BIOCHAR IN SWITCHGRASS PRODUCTION

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Biochar, a charcoal-like substance, is the byproduct of heating any organic material (such as switchgrass) at relatively low temperatures and with limited oxygen. This process is known as pyrolysis and is used for biofuel conversion. Pyrolysis produces heat, gases, a substance similar to crude oil (i.e. bio-oil), and biochar (Figure 1). If cellulosic bioenergy production reaches the scale that has been projected, millions of tons of biochar will be produced annually as a byproduct. One possible use of this byproduct is to apply it back onto switchgrass or other agricultural fields as a soil amendment. Such applications may improve soil carbon content and enhance nutrient additions. This could lead to a closed-loop system, considering the biochar is re-applied to switchgrass fields the following season. Yield responses from biochar applications have been mixed, from negative, no response, to positive. Positive responses may more likely occur from applications on sandy or less fertile soils. Burning high-carbon biomass and applying the resulting biochar to soils is not a novel concept — “terra preta” (or black earth) has been used to enhance Amazonian soil fertility for centuries.

Recent research at the UT Institute of Agriculture and elsewhere has shown that there are a number of benefits to applying biochar to switchgrass. First, biochar can increase fertility by adding and helping retain nutrients that are already present in the soil because those elements adsorb to biochar particles. Unlike some forms of organic matter, biochar is highly stable in soils and therefore, more resistant to decomposition. Thus application of biochar is a way to store carbon from plant residues (sequestration) in soils.

Figure 1. Biochar produced from switchgrass via pyrolysis at 400 C.

Biochar is low in nitrogen, as heating the feedstock causes the release of some compounds (such as nitrogen); whereas other nutrients (such as P, K, Mg and Ca) become concentrated in the remaining byproduct. Furthermore, most of the usable nutrients in biochar are released slowly, and the material can act as a liming agent in low pH (acid) soils due to its high ash content and alkaline nutrients.

Figure 2. Scanning electron micrograph of switchgrass-biochar.

Micrograph images reveal that extremely small pores are present in switchgrass biochars, thereby creating a "hotel" for beneficial soil microbes (Figure 2).Because of its coarse, friable particles, application and incorporation of biochar can increase soil aeration (Figures 2 and 3) and decrease bulk density (greater porosity) in soils (Figure 3). Reduced bulk density can lead to less compaction and better water infiltration. Therefore, biochar may positively influence soil water-holding capacity due to its adsorbent nature. In general, as biochar application rates increase, soils' ability to hold and retain water increases. Such increases may help sustain forage and/or biomass yields during drought.

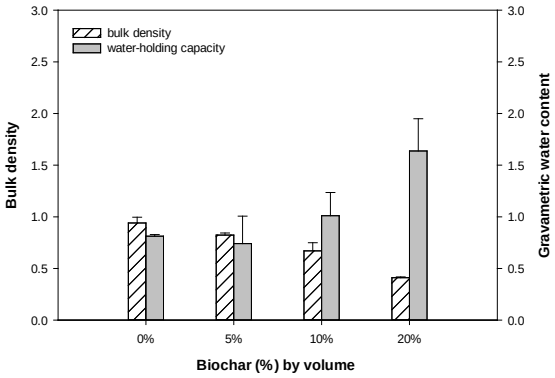

Figure 3. Bulk density and water-holding capacity (gravimetric water content at field capacity) of biochar-amended soils based on biochar concentration (Ashworth, 2014; unpublished data).

Because of the small particle size and dry state of biochar, applying it in ways that minimize dust and loss from wind or water erosion is important. Therefore, avoid applying during windy weather. Losses can also be reduced by incorporating biochar into soils, or by applying when soils are damp. Biochar can be applied to fields by mixing it with approximately 20 percent water and spreading it with a manure or lime spreader to the targeted dry rate (2-5 tons per acre; best rate still under investigation). Additionally, biochar can be applied by mixing it with animal manure or high-nutrient animal byproducts, an approach accomplished through composting. However, application rates should be based on dry weights and not on mixed slurries. Use of biochar as a soil amendment for biomass feedstock production may improve sustainability by coupling agricultural and bioenergy systems.