

DOES BIOCHAR-AMENDED SOIL BENEFIT PLANTS?

NACAA SFE application
Julie Weisenhorn
University of Minnesota Extension
weise019@umn.edu

DESCRIPTION OF PROJECT

The purpose of this four-year study (2012-2015) was to answer the question, "*Is biochar a good soil amendment for home landscapes?*" Biochar is a carbon-based byproduct of pyrolysis, the extraction of plant oil from biomass for biofuels. If biochar is shown to benefit the home garden environment, a market could emerge, encouraging farmers to grow biomass on marginal lands. This is a 5-year project involving eight Midwestern universities and is part of an initiative by the United States to lessen our dependence on foreign oil, to reduce greenhouse gas emission and increase local renewable energy. Extension Master Gardeners in Minnesota and Iowa were part of CenUSA Bioenergy Objective 9: Extension and Outreach (<https://www.cenusa.iastate.edu/>). [CenUSA Bioenergy](#) is supported by Agriculture and Food Research Initiative Competitive Grant No. 2011-68005-30411 from the USDA National Institute of Food and Agriculture.

Approximately 75 Master Gardeners (50 – MN, 25 – IA) studied the productivity of vegetables and flowers in biochar-amended soils in seven sites: (1) UMN St. Paul campus (St. Paul, MN) (2) UMN Landscape Arboretum (Chaska, MN); (3) UMN Regional Extension center (Andover, MN); (4) Brookston Community Center of the Fond du Lac Tribal Community (Cloquet, MN); (5) ISU Armstrong Research Farm (Lewis, IA); (6) ISU Horticulture research station in Gilbert, IA; (7) ISU Muscatine Island research Station in Fruitland, IA. Each site was led by Master Gardeners (MN) or staff (IA) and involved additional Master Gardener Volunteers with oversight by Extension staff. The Fond du Lac site also engaged youth in their project. This project was awarded a [national Search for Excellence award in research](#) at the International Master Gardener Conference, September 22, 2015, Council Bluffs, IA.

METHODS

The demonstration gardens were established in May 2012. Soil types varied between sites: silt loam (Arboretum, St. Paul) to sandy soil (Andover, Fond du Lac). Iowa soils ranged from very sandy to heavy clay. Initial soil tests were conducted by the respective university soil testing laboratories in spring 2012, with additional soil tests conducted in subsequent years. Prior to planting, soils were amended based on the soil test recommendations. In each demonstration site, three 300 ft² plots were established. Prior to planting, biochar and soil amendments were incorporated only in Year 1 using a tiller: control plot (no biochar added); treatment 1 plot (½ lb. biochar/ ft², total 150 lbs); treatment 2 (1 lb. biochar/ ft², total 300 lbs). The biochar used in this research project was generated from hardwood slash and donated by Royal Oak Industries. No biochar was added in subsequent years of the project. Granular fertilizer was added to the soil prior to spring planting based on soil test recommendations. No organic matter, pesticides or herbicides were applied throughout the study. In Minnesota, fencing was erected at all four sites

to protect crops from animal browsing. Depending on the site, garden irrigation ranged from in-ground irrigation (St. Paul) to oscillating sprinklers on timers (Andover) to hand watering using sprinklers (Arboretum and Fond du Lac). In all case, volunteers were responsible for ensuring plants were properly irrigated.

Crops that were popular and commercially available to MN and IA home gardeners were planted and grown each year: sweet basil, bush beans, carrots, cucumbers, kale, lettuce, peppers, potatoes and tomatoes, gazania, salvia and zinnias. Perennial crops included were hardy shrub roses, garden chrysanthemums and asparagus. All perennial plants and annual seed crops were purchased from the same source. According to the seed packet, seeds were either started in a designated local commercial greenhouse or direct sowed. Plants distributed by Extension staff to each state's locations.

Master Gardeners completed rigorous training each spring that covered project history, processes, gardening practices and data collection. Volunteers were instructed to follow best gardening practices as recommended by Extension. This included crop rotation, planting, plant spacing / thinning, sanitation, pruning / staking, irrigation, and integrated pest management. Volunteers collected weekly data on plant height and width, percentage bloom, and leaf color. Vegetables were harvested according to days to maturity, then weighed and measured. Issues such as germination failure, disease, or heavy insect damage was recorded by volunteers.

RESULTS & IMPACTS

Final results from the four-year study are currently being evaluated at the time of this publication. However, biochar appears to benefit sites with sandy (poor) soils and compacted soils. As participants in this project, Master Gardeners reported that they gained knowledge about biochar and research projects, and that they improved their observation skills regarding seed germination, insect presence and/or damage, and measurement of plant size and crop production. Differences have been observed in the growth rates, crop yield, soil compaction and water retention between treatments.

Extension outreach was an important component of this project. The demonstration gardens were located in public areas and included interpretative signage, plant labels, and treatment information. Master Gardeners were engaged and informed the public about the biochar project at community events, field days, site tours, regional conferences, webinars, and the Minnesota and Iowa State Fairs. The project was featured in respective university publications, on the [national Extension Master Gardener blog](#), and in a [CenUSA video](#). Extension was the focus of the CenUSA annual meeting in 2013 at the UMN Landscape Arboretum, featured a tour of the biochar demonstration garden by Master Gardeners. Results from all biochar sites are combined into quarterly and annual reports and distributed through CenUSA to members and stakeholders. This project was awarded a national Search for Excellence award in research at the International Master Gardener Conference, September 22, 2015, Council Bluffs, IA.

Iowa State Master Gardeners surveyed attendees during annual field days. In general, the responses positive and many asked about purchasing biochar. At the 2014 Minnesota State Fair,

an evaluation system was set up to capture the anonymous opinion of people who visited the display. The display presented current information about biochar and this project, and directed visitors to drop a glass pebble into a jar to indicate their potential for using biochar. Over the ten days of the MN state fair, 2516 visitors responded as follows: 1488 (59%) indicated they would use biochar; 26% indicated they would consider it; 378 (15%) indicated they would not add biochar to their gardens based on the current information.

Master Gardeners of the Fond du Lac tribal community chose to use the biochar demonstration garden at the Brookston Community Center (Cloquet, MN) to involve youth in the planting and care of the garden. Youth ages 6-14 learned basic gardening techniques as well as how to prepare the fresh vegetables, which they helped grow, adding a nutritional learning component.

SUMMARY

Biochar appears to have some benefit on poor and compacted soils, and an excess of biochar appears to have a negative effect on some crop yields. Final results from the four-year study are currently being evaluated. In addition to biochar data, this project confirmed that Extension volunteers engaged in research projects may show an increase in their own knowledge and improved observational and practical skills. Likewise, Extension volunteers may provide a means of significant outreach to the general public and stakeholders, and should be considered part of research projects requiring an outreach component.