Biochar and Managed Perennial Ecosystems

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Introduction

Biochar is a carbon-rich material that is similar to charcoal. It is produced when biomass is burned in the absence of oxygen, a process otherwise known as pyrolysis. Pyrolysis and the production of biochar are currently being promoted as a means to both produce domestic fuel (bio-oil) while concurrently producing a co-product that increases crop yield and sequesters carbon in the soil (biochar). While there may be many potential benefits in the application of biochar to agricultural soils, such as enhanced soil fertility and improved soil water status, there are no studies of higher-order ecological and ecosystem effects of biochar and its potential synergistic interactions (either positive or negative) on complex perennial systems. The goal of this field experiment is to determine how biochar and manure addition directly affect ecosystem structure and function in perennial systems, specifically soil nutrients, water, plants, and soil organisms.

Materials and Methods

In April 2011, we established five experimental blocks each containing six 4-m^2 plots (30 total plots). Within each replicate block, we randomly assigned plots to one of six treatments: factorial combinations of two nutrient addition levels (0 and 4.5 kg manure m^{-2}) and three biochar levels [0, 1%, and 3% of soil volume]. A diverse seed mixture of 30 tallgrass prairie species was planted following plot set up.

Results and Discussion

This past growing season, 2011, was the first year of our project, and the site was dominated by weedy annuals, such as foxtail grasses, western ragweed, horseweed, and buffalo bur (Figure 1). This is typical for a first year restoration and we anticipate that the planted perennials will be dominant in the coming year.

In this first year, we found that there was no difference in total plant biomass (weeds and planted species) among the biochar and manure treatments (Table 1). The biomass of just the planted species, however, increased in the 3 percent biochar treatment regardless of manure addition. Plant species richness was not affected by manure, but increased with 1 percent and 3 percent biochar additions. There was no difference between the biochar treatments, however.

Soil pH and gravimetric water content were not affected by the treatments (Table 1). Mycorrhizal colonization of plant roots was not affected by the biochar treatments, but decreased with biochar additions (Figure 2).

We will continue to monitor both above and below ground community development and nutrient levels over the next two years to determine how biochar may affect non-agricultural communities.

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Table 1. Mean plant community and soil parameters with biochar and manure treatments.

	No manure			Manure (4.5 kg/m^2)		
Biochar	**0**	**1%**	**3%**	**0**	**1%**	**3%**
Total biomass (g/m^2)	106.5	145.6	113.0	144.3	124.0	102.6
Planted biomass (g/m^2)	8.3	8.0	18.0	8.3	8.1	15.7
Species richness/m^2	9.6	11.0	12.2	9	13	12.8
pH	8.0	7.9	7.9	7.9	7.9	8.0
Gravimetric water content (%)	16.3	18.9	19.0	19.0	20.0	17.9

Figure 1. Experimental biochar plots, April (left) and August (right) 2011, Western Research Farm.

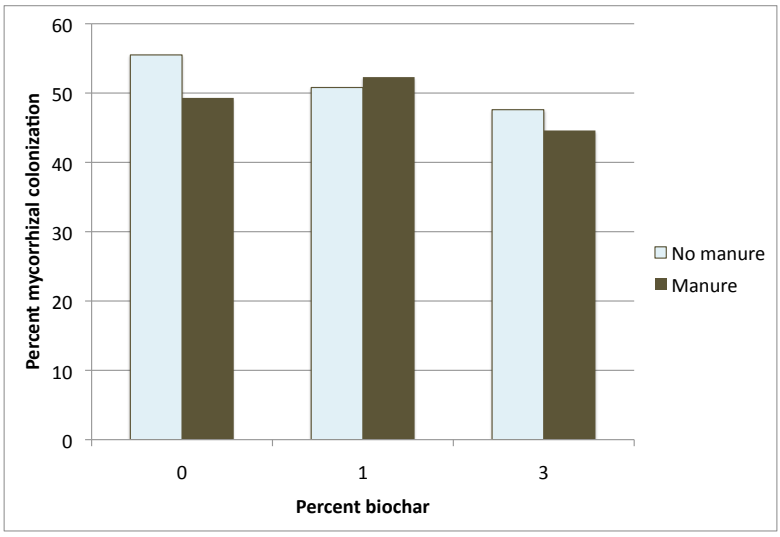

Figure 2. Changes in colonization of roots by mycorrhizae with biochar and manure treatments.