B25A-1430: Potential benefits of biochar and mycorrhizal fungi on shortleaf pine restoration in northcentral Alabama

Casey Iwamoto , Courtney Siegert, Joshua Granger, Krishna Poudel, and Adam Polinko
Department of Forestry, Mississippi State University

Introduction

The current extent of shortleaf pine (*Pinus echinata)* is estimated to be less than 10% of it's historical range[1] (Figure 1). This stems from a combination of factors such as climate change, pests, and the commercial preference of loblolly pine (*Pinus taeda*). Shortleaf pine has one of the largest native range in the southeastern United States and has potential to be used in widespread land restoration efforts on reclaimed mining sites. This is due to its ability to grow on low quality and acidic soil. Biochar and soil microbial amendments may further enhance restoration potential by increasing carbon sequestration, decrease bulk density, increase pH, and decrease the mobility of heavy metals[2,3].

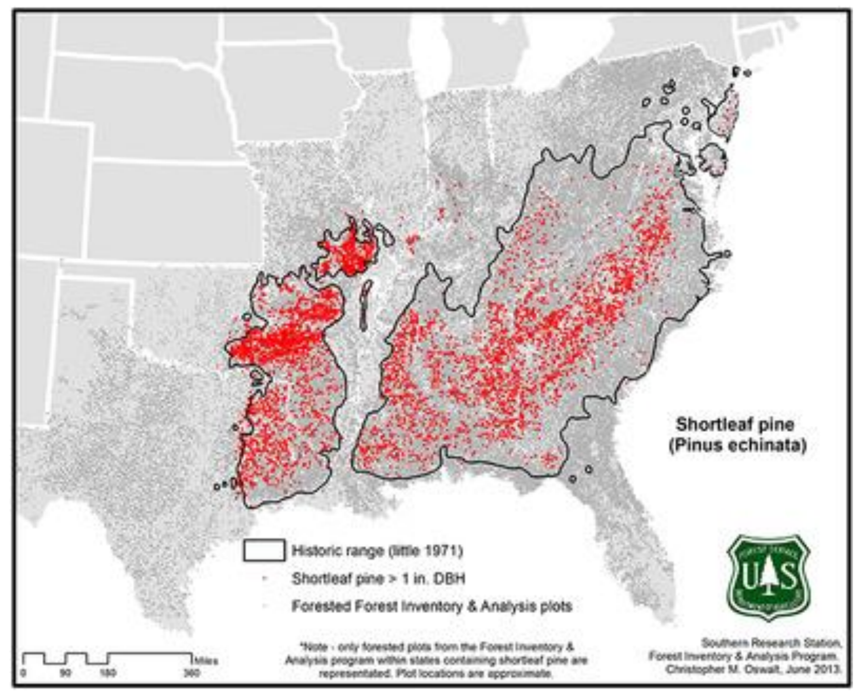

Figure 1. 2012 distribution of shortleaf pine on FIA forest plots within the historic shortleaf pine range . (Source) : Shortleaf Pine Initiative

Objectives

The primary objective of this study is to determine the impact of biochar and microbial soil amendments on soil health indicators and shortleaf pine productivity.

Methods

This study takes place in Winston County, AL. The experiment uses a fully factorial and complete randomized block design with two treatments: biochar and microbial inoculation (Figures 2). We have measured soil bulk density (BD), pH, electrical conductivity (EC), carbon content, and nitrogen content both before and after planting the shortleaf pine.

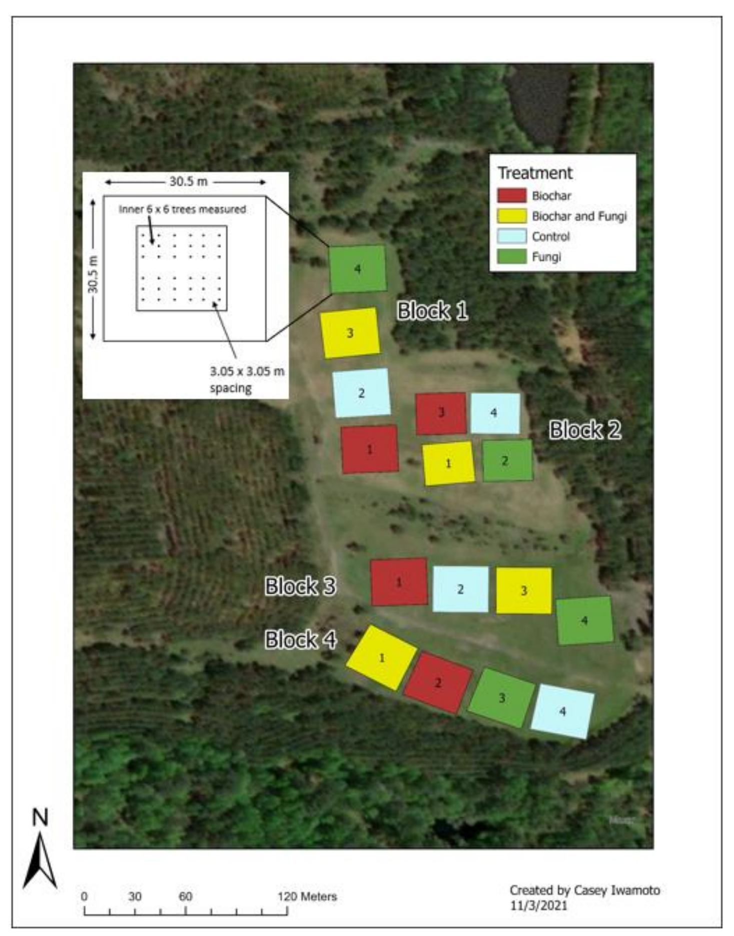

Figure 2. Experimental design and layout

Results

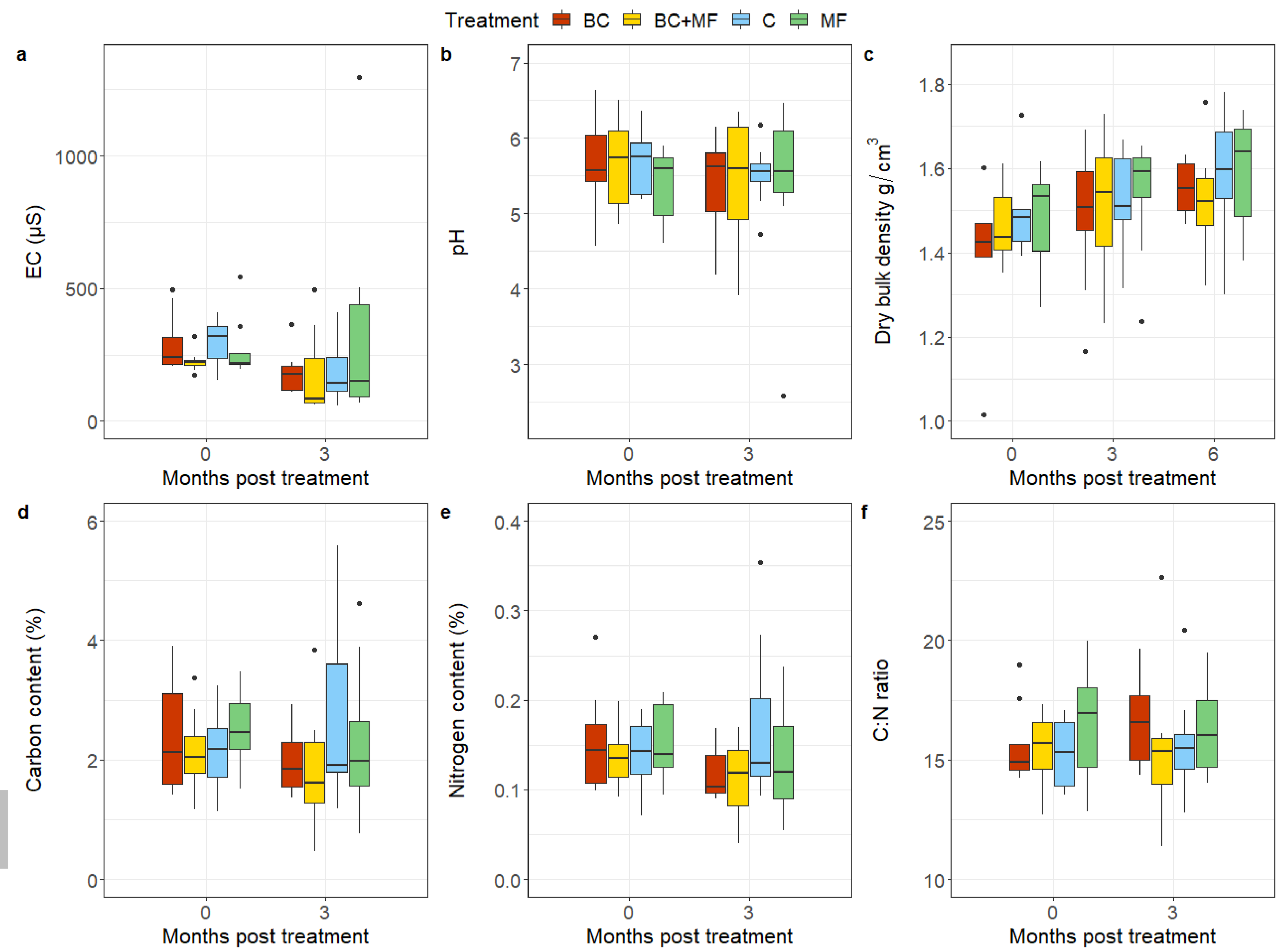

Figure 3. Measurements of soil health indicators at 0 months (pretreatment), 3 months, and 6 months after treatment. BC = biochar, BC+MF = Biochar and mycorrhizal fungi, C = Control, MF = Mycorrhizal fungi. (a) electrical conductivity (b) pH (c) dry bulk density (d) carbon content (e) nitrogen content and (f) carbon to nitrogen ratio.

Table 1. Survival, ground line diameter (GLD), and height of shortleaf pine after one growing season.

Treatment	Survival (%)		GLD (cm)		Height (cm)	
	At planting	End of growing season	At planting	End of growing season	At planting	End of growing season
Biochar	97.91 ± 1.33	77.78 ± 3.40	0.39 ± 0.11	0.66 ± 0.19	20.46 ± 4.77	36.23 ± 10.49
Biochar and mycorrhizal fungi	98.61 ± 1.39	74.31 ± 5.12	0.40 ± 0.12	0.60 ± 0.19	20.18 ± 5.14	34.48 ± 9.48
Control	95.83 ± 0.80	77.78 ± 7.44	0.39 ± 0.11	0.61 ± 0.19	20.78 ± 9.49	35.89 ± 10.37
Mycorrhizal fungi	98.61 ± 0.80	84.26 ± 8.82	0.38 ± 0.11	0.60 ± 0.15	19.81 ± 4.65	36.41 ± 12.91

Summary & Implications

- EC and pH show slight negative trends, while dry bulk density shows a clearer positive trend. C content, N content, and the C:N ratio show little change across the current time period (Figure 4).
- The current survival of shortleaf pine is within our expectations; however, the trees are not large enough to impact the soil yet (Table 1).
- These measurements also do not consider seasonal changes, but with future data collection we expect the soil amendments to:
    - increase soil pH, carbon content, and nitrogen content
    - decrease EC and bulk density.

Figure 4. Shortleaf pine planted Spring 2021

Figure 5. 10 cm soil core

Acknowledgements

- This work was funded by the National Fish and Wildlife Foundation and is a contribution of the Forest and Wildlife Research Center, Mississippi State University.
- Additionally, this material is based upon work that is supported by the National Institute for Food and Agriculture, U.S. Department of Agriculture, McIntire Stennis project under accession #11018784.
- Special thanks to Mark and Maggie Johnston for their support and generosity.
- [1]Sutter, R. (2020). *Ecological and Social History of Shortleaf Pine*. Shortleaf Pine Initiative. http://www.shortleafpine.net/
- [2]Blanco-Canqui, H. (2017). Biochar and Soil Physical Properties. *Soil Science Society of America Journal*, *81*(4), 687–711. https://doi.org/10.2136/sssaj2017.01.0017
- [3]Rees, F., Simonnot, M. O., & Morel, J. L. (2014). Short-term effects of biochar on soil heavy metal mobility are controlled by intra-particle diffusion and soil pH increase. *European Journal of Soil Science*, *65*(1), 149–161. https://doi.org/10.1111/ejss.12107
- Contact information: Casey Iwamoto, Graduate research assistant, ci175@msstate.edu