Examining the Effect of Biochar on Invasive *Typha* × *glauca* in a Greenhouse Experiment

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Abstract

Invasive species in the Great Lakes pose ecological, economic, and social dilemmas as they alter and diminish the quality of ecosystems. By dominating native plant communities through efficient uptake of excess nutrients, the hybrid cattail, *Typha* × *glauca*, reduces the plant diversity of Great Lakes coastal wetlands, impacting habitat for many species of fish, animals, and insects. This study investigated how biochar, a charcoal-like substance, affected biomass accumulation in hybrid cattails and native wetland plants. I conducted a greenhouse experiment by growing assemblages of native wetland plants, *Typha* × *glauca*, and a combination of both native species and hybrid cattails in different rates of biochar. I found that biochar reduced the overall biomass of *Typha* × *glauca* when comparing the three rates. Biochar was also found to impact the phosphorus content in *Typha* × *glauca*, a nutrient which is often found in excess in wetlands due to agricultural pollution. This preliminary study provides evidence that biochar has the potential to reduce the biomass of *Typha* × *glauca*, therefore impeding its dominance in Great Lakes coastal wetlands.

Introduction

Great Lakes Coastal Wetlands (GLCWs) are continually under threat by invasive species, chemical and nutrient runoff, habitat loss, and other human disturbances. *Typha* × *glauca* (hereafter *Typha*) is an aggressive invasive hybrid of *T. latifolia* and *T. angustifolia* that produces monocultures, leading to dense growth and abundant organic litter (Larkin et al., 2011). *Typha* monocrops tolerate a wide range of conditions, thus preventing native plant species from thriving in sedge meadow and emergent wetland zones. Furthermore, Typha's tall stature and dense organic litter out-competes native plants for light and other abiotic ecological components, such as space and other nutrients (Larkin et al., 2012). In GLCWs, *Typha* is highly competitive in eutrophic conditions due to its ability to take up nutrients from agricultural nutrient runoff and urban sewage (i.e. phosphorus (P) and nitrogen (N)) (Carson et al., 2018). Biochar is a porous, negatively charged charcoal-like substance made from organic material burned at high temperatures in anoxic conditions (Liang et al., 2006). This allows for biochar to adsorb cations such as N and P from excess fertilizer and agricultural runoff. Recent studies of biochar in wetland mesocosm systems have shown decreases in phosphate, ammonium, and nitrate leaching for sediments (Rubin et al., 2020). This research indicates that biochar's potential to bind nutrients may decrease *Typha*'s competitive edge under eutrophic conditions in GLCWs (Galatowitsch et al., 1999).

Methods

A greenhouse experiment was conducted at the University of Michigan Biological Station to test the hypothesis. 72, 2 gallon bucket microcosms were filled with a homogenized sand-compost mixture to mimic nutrient polluted GLCW sediment. Biochar produced from pyrolyzed wooden pallets was obtained from Chip Energy of Goodfield, Illinois. The biochar was crushed and mixed into the microcosms at rates of 0, 2.5, and 5% by weight of the sand-compost mixture. Three species of macrophytes were collected in Cheboygan Marsh, including *Typha* × *glauca*, *Schoenoplectus acutus*, and *Juncus balticus*. Rhizomes were thoroughly washed to remove all wetland sediments. Rhizomes were cut to ensure homogenous starting conditions. Three different plant assemblages were formed: Typha, native, and full. Typha mesocosms contained one *Typha* × *glauca rhizome.* Native communities included one *S. acutus* and one *J. balticus* rhizome. Full communities included one of each of the three species. 8 replicates of each community were planted in each of the three biochar rates for a total of 72 microcosms. After 50 days, soil samples were collected for nutrient testing. The wet and dry weights of each plant rhizome were recorded, as well as their lengths. Above ground plant biomass was also dried and ground to be sent to the Kansas State University agronomy lab for further testing.

Results and Conclusion

Results show that *Typha* plants in microcosms containing 2.5% biochar and 5% biochar had significantly less biomass than those in microcosms with no biochar application ($p = 0.0055$ and $p=0.0057$ respectively). No significant differences were found in nitrogen content between *Typha* plants across the three biochar levels. A significant difference was found in phosphorus content of plant tissues between the 0% and 2.5% biochar rates ($p = 0.017$). However, the 2.5% biochar rate had a greater phosphorus content, which was not hypothesized. Further investigation must be done with collected data to better understand the relationship between biochar and *Typha* growth.

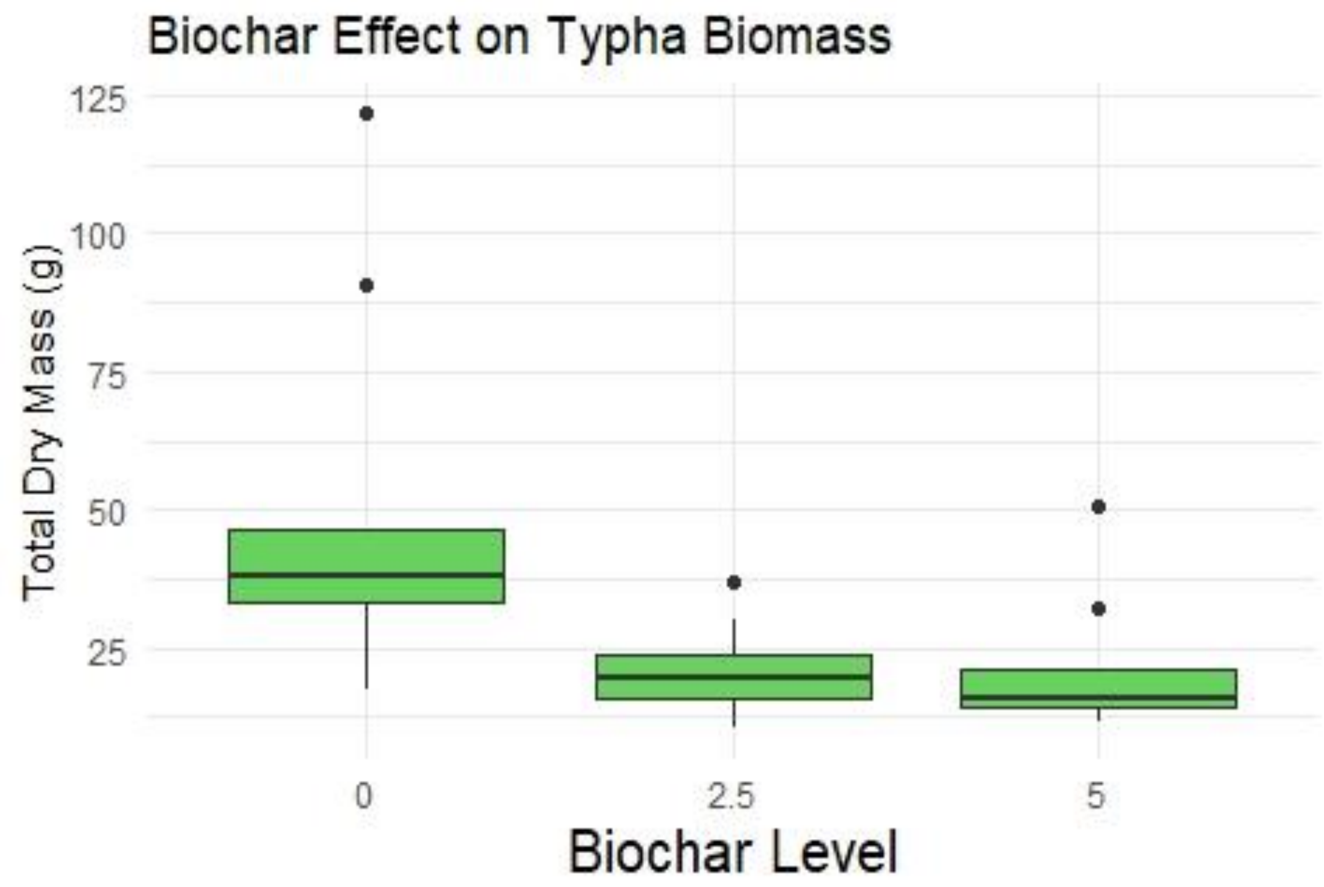

Figure 1: Displays the significant difference in final dry mass of *Typha* plants between 0% and 2.5% ($p = 0.0055$) and 0% and 5% ($p = 0.0057$) biochar rates.

Citations

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