

Effects of Biochar on Drought Tolerance of *Pinus banksiana* Seedlings

Laura F. Reuling, Alan J. Z. Toczydlowski, Robert A. Slesak,
Marcella A. Windmuller-Campione

Overview:

- With climate change, seedlings are likely to experience more prolonged and more extreme drought.
- Biochar has been proposed as a soil amendment that could increase water holding capacity in soils, reducing drought impact on planted seedlings.
- In a greenhouse experiment, we did not see any significant effect of biochar as a soil amendment on growth or survival of *Pinus banksiana* seedlings subjected to low water availability or increasing levels of drought duration.
- Field trials are needed to determine if biochar may be more effective when seedlings develop under ambient field conditions.

Summary:

In the upper Midwest, climate change is expected to result in longer periods of drought during the growing season and increased summer temperatures. These pose a particular threat to seedlings, both natural and artificial regeneration, which are more susceptible to drought than mature trees. Biochar, a product created through pyrolysis of organic material (including wood and wood waste), has been proposed as a soil amendment that can both increase the water-holding capacity of soil (and therefore increase the drought tolerance of seedlings in that soil) and increase carbon storage. In this experiment, we used a greenhouse setting to test whether the addition of biochar to sandy soil would increase the survival of jack pine (*Pinus banksiana*) seedlings under drought conditions. We tested three amounts of biochar (none, 3% biochar by weight, and 6% biochar by weight) in two separate experiments. The first experiment manipulated timing of drought onset; seedlings received a sufficient amount of water until week 3, 7, or 11 after planting and then no water after that. We evaluated effects of both biochar and drought timing on seedling survival. In the second experiment seedlings received water throughout the experiment, either in low (20 ml) or high (200 ml) amounts every other day. In this experiment, we assessed the effects of both biochar and water amount on seedling growth and on seedling physiological processes.



Silvicultural Concepts:

- Biochar was not found to have a significant effect on seedling survival or growth in either experiment.
- Timing of drought onset also did not have an effect on seedling survival (fig. 1). Seedlings experiencing a drought beginning in week 3 after planting survived approximately the same number of days of drought as seedlings experiencing a drought beginning in week 11. A longer establishment time did not give seedlings an advantage to survive the drought.
- In experiment 2, watering level (low vs. high) had a significant effect on both seedling height and seedling basal diameter (fig. 2). Seedlings receiving more water were both taller and had larger diameters, but the differences in diameter were much more pronounced than the height differences. Seedlings receiving a low amount of water seemed to allocate resources to height growth over diameter growth.

Management Applications:

- Our findings did not support the hypothesis that the addition of biochar to soil will help seedlings survive drought in sandy outwash soils.
- However, since we did not find any impact of biochar to seedling growth or survival (positive or negative), biochar may be able to be added to soil for other reasons (such as carbon storage) without having a negative impact on seedlings.
- Seedlings receiving little water allocated more resources to height growth than diameter growth, which may mean that seedlings experiencing drought conditions can meet height requirements for regeneration to be considered successful, but still have significant growth deficiencies in stem diameter.
- Additional field trials should be performed to determine if seedling development under field conditions is influenced by biochar addition.



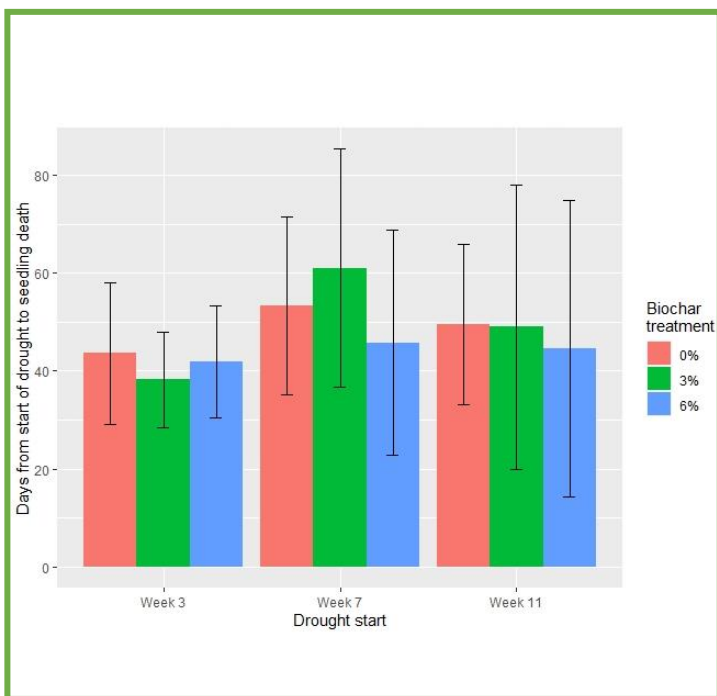


Figure 1—Experiment 1: Seedling survival after drought onset by biochar treatment and drought start week.

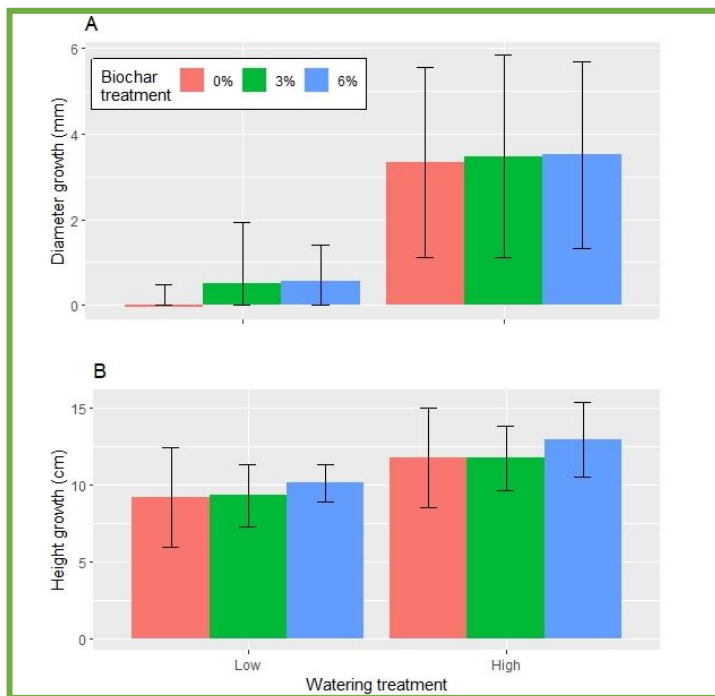


Figure 2—Experiment 2: Seedling (A) diameter and (B) height growth from time of planting to end of experiment by biochar treatment and watering level treatment. Error bars represent one standard deviation.