Testing the Potential of Biochar to Improve Bareroot Nursery Efficiencies

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Overview:

- Excessive woody biomass from forest sites can be used to create biochar that can be used in forest nurseries.
- Biochar applications add carbon to soils, which increases nutrient and water retention.
- We applied biochar at a rate of 0.5 tons/acre to bareroot beds at Lucky Peak and Bessey nurseries.
- Early results indicate that biochar can increase the amount of nitrate and ammonium available to plants and decrease the amount lost to leaching.
- Biochar also increases available water in the root zone, which has the potential to reduce irrigation frequency.

Summary:

One way to increase conversion of woody residues often burned in slash piles into a value-added product is to expand markets for biochar. Biochar has been used to increase the growth of agricultural crops, grass, and urban trees and it has also been used as replacement for *Sphagnum* peat moss, perlite, or vermiculite in growing substrates for container seedlings (Dumroese et al. 2020). Using biochar in bareroot nursery beds is an opportunity for improving soil properties while also reducing nutrient and irrigation inputs. After 1 year, biochar reduced the amounts of NO_3^--N (fig. 1) leaching downward through the soil profile and increased the amount of soil solution NH_4^+-N (fig. 2) at the 10 cm depth. This nitrogen data highlights the importance of adding a high-carbon substrate (biochar) to limit fertilizer losses. One benefit often described about biochar additions to soil, particularly coarse-textured soil, is the ability to increase plant available water (Page-Dumroese et al. 2017). At the Bessey Nursery, biochar increased plant available water at the 5 cm soil depth as compared to the control. Plant available water at 15 cm was, however, less after biochar application. This is likely because biochar may have retained more water in the upper soil profile rather than allowing it to move downward in the soil profile. Biochar has also been shown to reduce soil bulk density (Page-Dumroese et al. 2017), which can also improve root growth and prevent

root defects. In addition, biochar can reduce *Phytophthora* expansion in nursery beds (Zwart and Kim 2012). To date, no deleterious impacts of biochar to bareroot nursery soils have been observed.

Silvicultural Concepts:

- Many forests have excess woody biomass created during fuels reduction, thinning, or other harvest activities.
- Excess woody biomass can be converted to biochar rather than burned in slash piles using in-woods processing systems or creating slash piles to maximize biochar production.
- Conversion to biochar emits less emissions than burning slash piles.
- Distributing the biochar to local nurseries can improve bareroot nursery bed soil while also sequestering carbon.
- Biochar can improve soil health and produce healthy seedlings with fewer fertilizer and irrigation inputs.

Management Applications:

- Soil scientists, land managers, and nursery managers have an opportunity to convert excess woody biomass into a high-value, high-carbon product that can be used in bareroot nursery beds.
- Biochar increases soil organic matter content and can reduce nutrient leaching while increasing plant available water. Higher soil organic matter content has implications for pest control, especially fumigation.
- In addition, biochar is a tool to sequester carbon for many decades while reducing the risk of wildfire on public lands.

References

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Page-Dumroese, D.S.; Coleman, M.; Thomas, S.C. 2017. Opportunities and uses of biochar on forest sites in North America. In: Biochar: A regional supply chain approach in view of climate change mitigation. Chapter 15. Cambridge, UK: Cambridge University Press.

Zwart, D.C.; Kim, S.H. 2012. Biochar amendment increases resistance to stem lesions caused by *Phytophthora* spp. in tree seedlings. HortScience. 47: 1736–1740.

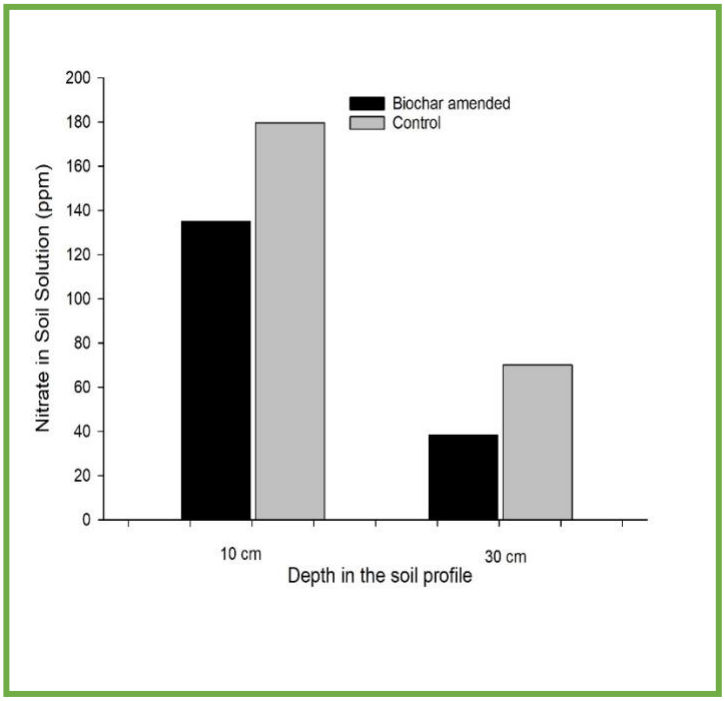

Figure 1—Nitrate in soil solution in plots with 0.5 tons/acre biochar and the control at the Bessey Nursery.

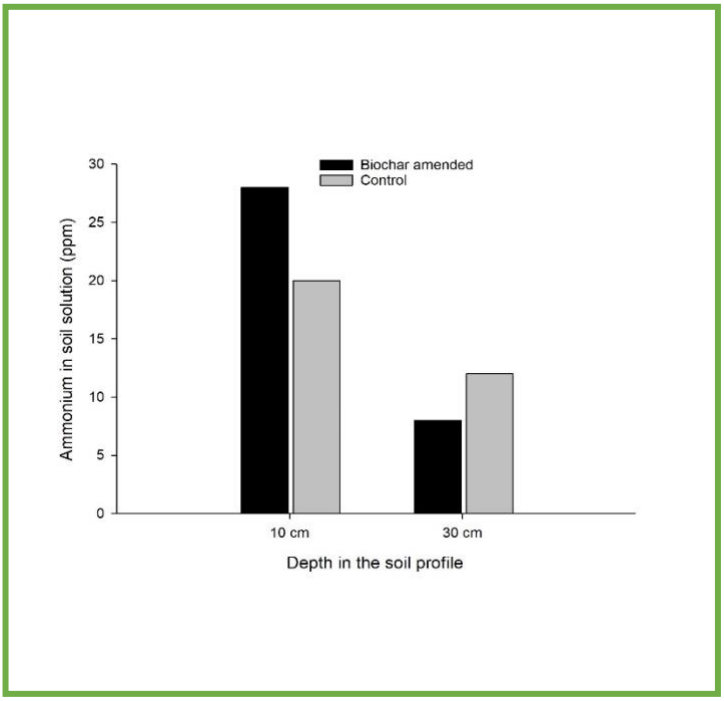

Figure 2—Ammonium in soil solution in plots with 0.5 tons/acre biochar and the control at Bessey Nursery.

Table 1—Soil bulk density and available water one year after applying 0.5 tons/acre biochar

Treatment	Soil depth (cm)	Bulk density (Mg m^{-3})	Available water (%)
Control	5	1.7	4.3
	15	1.6	5.7
Biochar	5	1.6	5.4
	15	1.7	3.6