BIOCHAR SEED-COATINGS FOR PRECISION AERIAL SEEDING IN FOREST RESTORATION

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Forest regeneration problems occur frequently on sites with degraded soils. In Canada, such degraded sites commonly make up 10-15% of operational forest areas. There is widespread agreement that increased forest regeneration on such sites has the potential to enhance forest ecosystem services, ranging from timber production and carbon sequestration to wildlife habitat. Tree-planting is expensive and often insufficient for site restoration, particularly at remote locations. Use of unmanned aerial vehicles (UAVs) for precision seeding in forest restoration is an emerging technology to address this issue. Unlike conventional seed release from helicopters or fixed-wing aircraft, UAVs can deliver seeds directly to targeted microsites suitable for germination and plant establishment, thus greatly reducing seed wastage and increasing the control of seeding density and distribution. However, automated devices for storing and releasing seeds from UAV platforms generally require some form of seed encasement for proper operation and to reduce wind transport after release. The present research explores the use of biochar-based seed coatings to enhanced germination and early plant establishment in this context.

Early research on seed coatings in forestry commonly found inhibitory effects where coatings acted to either reduce seed imbibition or physically impede radicle extension growth; however, only non-organic agents (such as vermiculite) were generally studied. There has been only limited research on biochar effects on the earliest stages of plant development, with a focus on agricultural species. However, in a recent field study we documented positive effects of biochar on early seedling development in a range of north temperate and boreal tree species, with more than a twofold average increase in radicle extension (Thomas 2021). Possible mechanisms for this effect include “seed priming” due to increased pH and/or potassium availability, or biochar sorption of phenolic compounds that inhibit tree seed germination in situ.

We have examined alternative formulations for biochar-based seed coatings in a series of lab, greenhouse, and field trials. Due to its low price and wide availability, polyvinyl acetate (PVAc) is in wide use as a binding agent for seed coatings. We found that biochar coatings using PVAc typically inhibited seed germination and early development. This is likely to due to phytotoxic effects of compounds derived from PVAc, as this effect was reduced by leaching of coated seeds, and PVAc applied in solution inhibited germination. We tested a range of alternative organic binding agents in germination trials, finding several candidate agents. In spite of inhibitory effects on germination, greenhouse and field trials showed large positive effects on seedling development (Fig. 1) even for biochar seed coatings using PVAc. Current trials are directly examining alternative binding agents and optimizing coating thickness, biochar particle size, and production details.

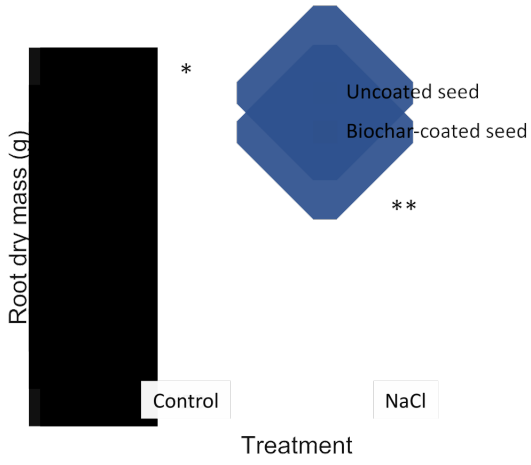

Figure 1: Example of greenhouse trial indicating large potential benefits of biochar seed coatings to seedling root growth. Greater beneficial effects were observed under applied stresses, such as irrigation with saline water.