Fertilizer and Microbial Inoculation Effects on Jack Pine Root Dynamics

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Key Words

root dynamics, rhizobacteria, ectomycorrhizae, jack pine, slow-release fertilizer, minirhizotron

Introduction

Many microorganisms can provide beneficial effects to newly planted tree seedlings. Microbial populations in forests, however, can be reduced by harvesting, particularly on cold, dry sites (Dixon, 1987). Fire has also been shown to decrease microbial populations, but these tend to recover within a few days (Hendrickson et al., 1982). Slow release fertilizers have also been shown to increase seedling growth after outplanting, though these results have been inconsistent (Gleason et al., 1990). Inoculation with microorganisms and fertilization are methods currently being used by forestry companies to improve the growth and survival of seedlings. However, little is known about the root system dynamics of boreal forest species as well as how these dynamics are influenced by additions of fertilizer or inoculation with microorganisms.

Objective

The purpose of this study was to determine the effects of slow-release fertilizer and inoculation with a rhizobacteria *(Burkholderia cepacia)* and an ectomycorrhizae *(Hebeloma cylindrosporum)* on the root dynamics of jack pine *(Pinus banksianna* Lamb.) seedlings.

Materials and Methods

Three study sites were established on Brunisol soils in Northern Saskatchewan. The Stewart Lake site was harvested three years before planting, the Beauval site had been harvested six months previous to planting, and the Hay Creek site had been burned in 1995 and salvage harvested the year before planting. Minirhizotron tubes were installed at each site to monitor jack pine and other root growth over the 1997 growing season. Four treatments were applied at each site; a slow-release fertilizer (16-6-8), inoculation with a rhizobacteria *(Burkholderia cepacia)*, inoculation with an ectomycorrhizae *Hebeloma cylindrosorum)*, and a control. They were replicated three times in a randomized block design, though the Beauval site had unbalanced replication. Five jack pine seedlings (1 +0) were planted next to each minirhizotron tube for each treatment, resulting in 12 tubes per site. Root dynamics were measured by inserting a miniature video camera into clear tubes installed in the ground and recording root images on a monthly basis. Jack pine and native vegetation roots were measured for root length and morphology (white, brown and bifurcation, which is caused by mycorrhizae infection).

Results and Discussion

Jack Dine root growth

After the first growing season none of the treatments had a significant effect (α 0.05) on jack pine root growth. However, some trends were apparent (Figure 1 a, b, c). Mycorrhizae treated seedlings had the most root growth at the Beauval and Hay Creek sites, while fertilizer seedlings had the best growth at the Stewart Lake site. The bacteria inoculation did not appear to increase root growth, even though the bacteria was found to have colonized the root system (data not shown).

Replication and site were found to have a significant influence on both jack pine and ‘other’ root growth, though not consistently over time (α 0.05). Seedlings planted at the Beauval site tended to have the best root growth. This was not expected since this site received the least amount of precipitation over the growing season. The burn site (Hay Creek), which received the most rainfall over the growing season, had relatively poor root growth.

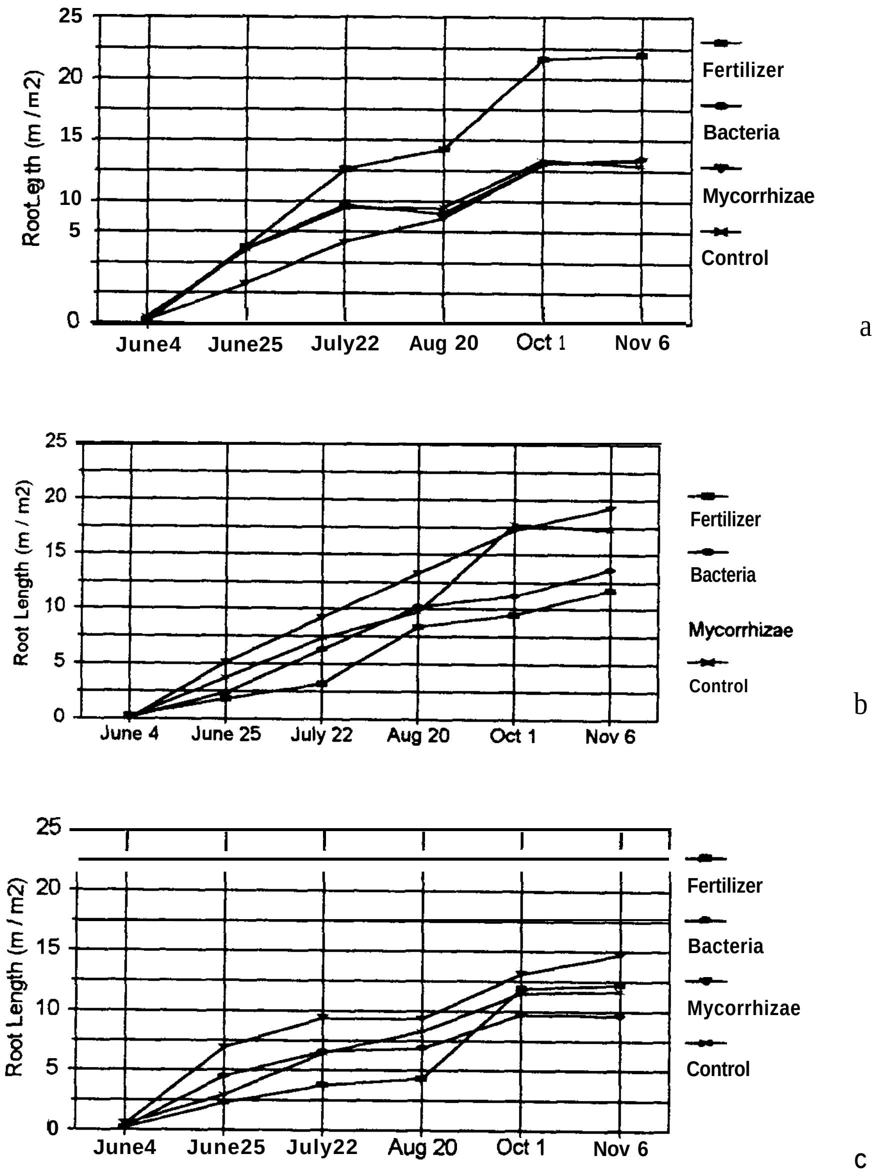
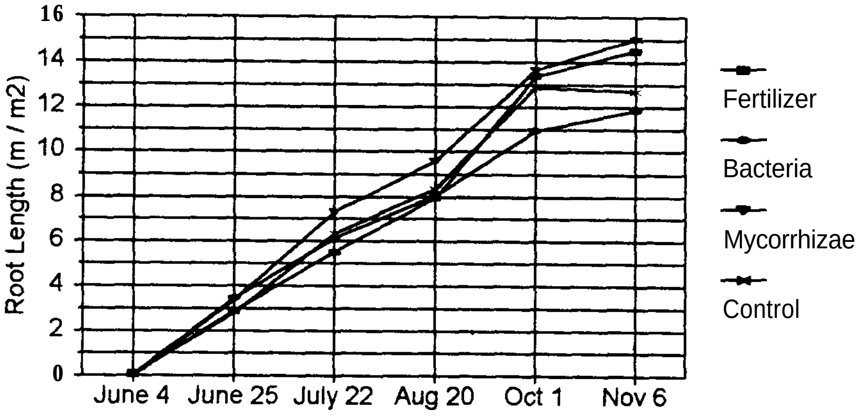


Figure 1. Average jack pine root length (m/m^2) at the Stewart (a), Beauval (b), and Hay Creek (c) study sites.

Jack vine root morphology

Jack pine root growth varied over the first growing season (Figure 2 a,b,c). White root growth peaked at the end of June to mid July. Brown root growth continued to increase to the end of the season. Root bifurcation began to level off by October 1 for most treatments, though it was still increasing in the fertilizer treated seedlings.

Treatments, while not significant (α 0.05) when compared over all sites, did appear to influence jack pine root growth. Fertilizer and mycorrhizae treated seedlings tended to have the most white and brown root growth, while the control and bacteria treated seedlings had comparable root growth. The control seedlings tended to have the most root bifurcation. The type of mycorrhizae infecting the roots was not determined. When measuring root bifurcation only new roots were measured since the seedlings had all been infected with an unknown mycorrhizae in the nursery.



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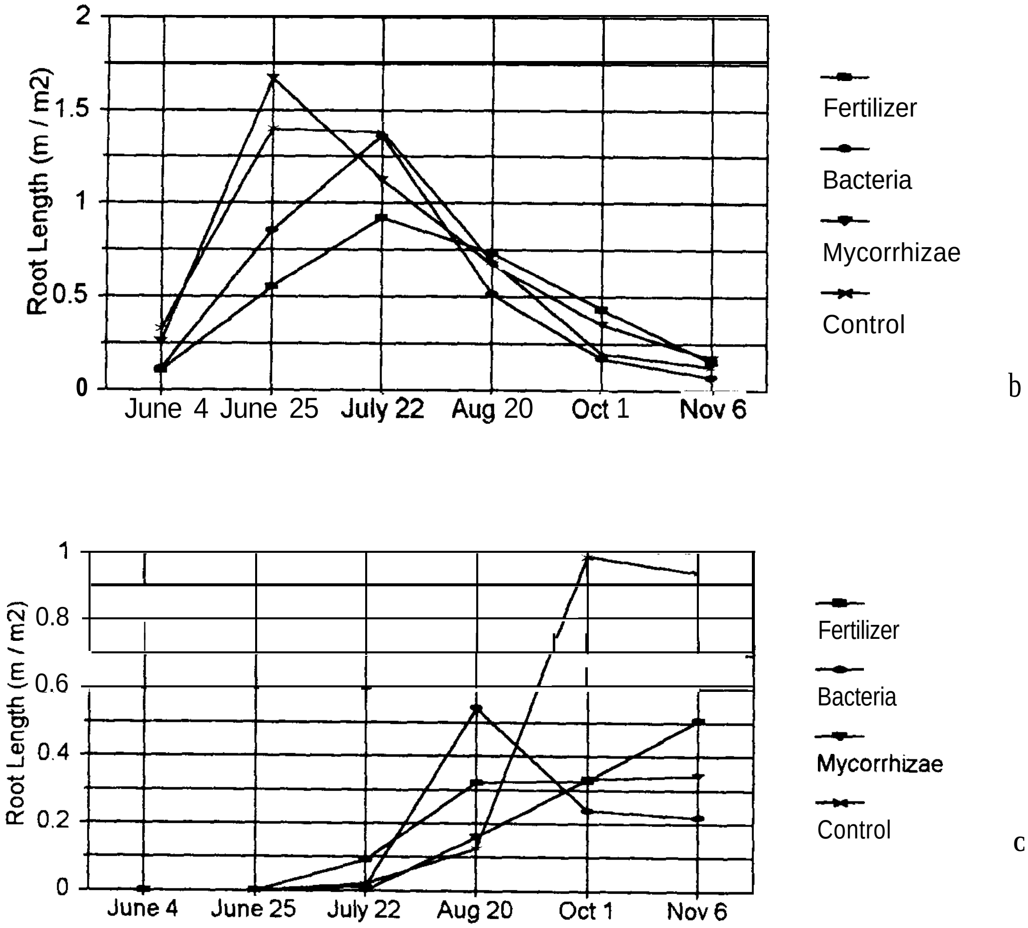

Figure 2. Average brown (a), white (b), and bifurcated (c) root growth (m/m’) for jack pine, combined over all three sites.

<u>Native vegetation root growth</u>

Native vegetation root growth tended to follow the same trend as that for the jack pine roots, with the Beauval site having the most root growth and Hay Creek the least (Table 1). The treatments did not significantly affect the root growth of the native vegetation, though replication and site significantly affected root growth during part of the growing season (α 0.05).

Table 1 Average root lengths (m/m^2) at the end of the growing season.

Site	Pine LSD $_{(\alpha\ 0.05)}$ = 3.37	Other LSD $_{(\alpha\ 0.05)}$ =7.55	Total
Beauval	16.80	19.24	36.04
Stewart Lake	15.44	20.04	35.48
Hay Creek	12.04	9.26	21.30

Conclusion

Minirhizotrons are an effective method for studying root dynamics in situ. This method allowed for repeated measurements without disturbing the rooting zone.

Treatment effects had no significant influence on jack pine or native vegetation root growth in the first year. Mycorrhizae and fertilizer tended to have the best root growth, while the bacteria treated seedlings and the control had comparable root growth.

The burned site had the lowest root growth for all treatments compared to the unburned sites, suggesting that this fire may have had some negative impact on root growth. Further work is needed to determine how soil processes are affected by harvesting and fire disturbance and their impact on root dynamics.

References

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