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The roles of nitrogen and phosphorus in increasing productivity of western hemlock and western redcedar plantations on northern Vancouver Island

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Abstract

Early evidence front a suite of fertilization trials on northern Vancouver Island indicated that conifers growing on cedar-hemlock (CH) cutovers were severely deficient in nutrients, particularly N and P, and that fertilization ought induce a sustained improvement in tree growth on these sites. Here we report the long-term (15-year) effects of two fertilization experiments which allowed us to distinguish the influences of N and P additions on productivity of western hemlock *(Tsuga heterophylla* Raf. Sarge) and western redcedar *(Thuja plicata* Donn.) regenerating on CH sites. Plots of each species were fertilized with N alone, P alone, or N and P combined. Nitrogen was added twice at rates of 0-400 kg/ha. P was added at 0 or 100 kg/ha. and subplots received a second fertilization 10 years after the first.

Hemlock responded to the first application of N, and growth was greatest where both N and P were applied. Ten years after the first fertilization, hemlock volume in plots receiving the highest rate of N and P was 10-times that in untreated plots. The second N application increased hemlock growth only in plots that had received P. Fifteen years after the first fertilization, height response of dominant hemlocks was still increasing in plots fertilized with both N and P but was declining in plots fertilized with N alone. In contrast to hemlock, western redcedar stand volume more than doubled 15 years after N fertilization, hut there was no additional effect of P fertilization. The long-term growth responses measured in these field experiments support earlier indications that P is an important limiting factor for productivity of conifers, particularly hemlock on these sites.

Keywords: Fertilization: Productivity: *Nitrogen: Phosphorus: Tsuga heterophylla: Thuja*

1. Introdudion

The productivity of northern coniferous forests is often limited by low nitrogen (N) availability, as evident in the growth responses reported following N fertilization of jack pine *(Pinus banksiana* Lamb.) (Weetman et al., 1995), Douglas-fir *(Pseudolsuga menziesii (Mirk-0* Franco) (Chappell et al., 1991: Weelman et al., 1997), Scotch pine *(Pious sylvestris L.),* and Norway spruce *Picea abies (L.)* Karst.) (Ingerslev et al., 2001). Although tree growth responses to N fertilization can he large, they usually persist for only a few years after N fertilization (Miller, 1981: Fisher and Binkley, 2000), largely as a result of immobilization of N in the soil (Binkley, 1986). Sustained growth response and increased N availability have occasionally been reported: for example application of 470 kg ha^{-1} or more elevated tree growth and N availability in a Douglas-fir *(Pseudolsuga menziesii* (Mirb.) Franco (Binkley and Reid 1985; Strader and Binkley. 1989) and in a jack pine *(Pinus*

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