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Phosphorus Additions Increase the Early Growth of Red Alder (*Alnus rubra* Bong.) on Vancouver Island

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ABSTRACT

The effects of nutrient additions on growth of the red alder (*Alnus rubra* Bong.) are not well known. We examined the growth and nutritional responses of 10 young (0–4 years old at time of fertilization) red alder plantations on eastern Vancouver Island to additions of phosphorus (P), added as triple super phosphate, and a blended fertilizer (F) containing elements other than nitrogen (N), P, and calcium (Ca). Site fertility classes ranged from poor to very rich and soil moisture regime classes ranged from moderately dry to very moist. Nutrients were added in single-tree plots and responses were measured for up to 3 years after fertilization. In plantations fertilized within 1 year of planting, P additions increased heights (average of 17%), basal diameters (28%), and stem volumes (68%) over a 3-year period and increased 1st-year foliar concentrations of P, N, and S. The fertilizer supplying other elements also increased concentrations of N and S, along with potassium (K), boron (B), zinc (Zn), and manganese (Mn), but increased volume by only 16%. These data suggest that deficiencies of P are more likely to limit the growth of young red alder than are deficiencies of other elements. Older plantations (more than 2 years postplanting) were less responsive to fertilization than were younger plantations (less than 2 years postplanting). Growth of young red alder appears limited by P availability when soil Bray-P and foliar P concentrations are less than approximately 12 mg kg^{-1} and 2 g kg^{-1}, respectively.

Keywords: red alder, phosphorus, nutrition, plantations

Red alder (*Alnus rubra* Bong.) is the most widespread deciduous broad-leaved tree species in low-elevation forests of coastal northwestern North America. Alder aggressively colonizes recently disturbed sites and has rapid juvenile growth rates (Harrington 1990). Long considered an undesirable competitor with its coniferous associates, red alder fixes substantial quantities of atmospheric nitrogen (Binkley et al. 1994); is immune to laminated root rot, *Phellinus weirii,* a serious pathogen of coastal Douglas-fir forests (Thies and Sturrock 1995); can provide a variety of valuable wood products (Tarrant et al. 1994); and contributes to habitat diversity in a conifer-dominated forest landscape. Increased harvest of mature alder has led to concerns that the current inventory of red alder will not meet projected demands (Mason 2003, Tarrant et al. 1994).

The extent to which elemental deficiencies limit the growth of red alder is unknown. Phosphorus (P) deficiencies are of particular interest because plant requirements for P are high, compared with most other elements, and because nodulation and N_2 fixation may be P demanding (Sanginga et al. 1989, Marschner 1995, but see Reddell et al. 1997). In field studies, site index increased with available soil and foliar P concentrations (Courtin 1992, Harrington and Courtin 1994). Alder, grown on a site previously containing alder, grew less and had lower tissue concentrations of P, calcium (Ca), and magnesium (Mg) than did alder grown on an adjacent site previously containing Douglas-fir (Cole et al. 1990, Compton et al. 1997). Additions of P (Radwan and DeBell 1994, Brown and Courtin 2003a) and sulfur (S) (Binkley 1986) increased the growth of potted seedlings in soils from alder stands, but liming did not (Brown and Courtin 2003a). In young plantations, additions of P increased (Radwan and DeBell 1994, Brown 1999, Brown and Courtin 2003b) or did not affect (Harrington and DeBell 1995, Hurd and DeBell 2001) growth. Additions of potassium (K), Mg, S, and trace elements did not increase growth over one growing season (Brown 1999).

In British Columbia, low-elevation sites on eastern Vancouver Island and the Sunshine Coast have the greatest potential for intensive management of red alder (Massie et al. 1994). The objective of this study was to determine what, if any, elemental deficiencies limit the growth of young red alder on eastern Vancouver Island. Effects of elemental additions on growth and nutrition were examined for up to 3 years after fertilization.

Methods

Study Sites

Ten experiments were established from 1997 to 1999 on southeastern Vancouver Island (Table 1). Study sites were in the Coastal Douglas-fir moist maritime (CDFmm) or Coastal Western Hemlock very dry maritime (CWHxm) biogeoclimatic subzone (Green and Klinka 1994). Soil moisture regimes (SMR; Green and Klinka 1994) ranged from moderately dry to very moist. Soil nutrient regimes (SNR; Green and Klinka 1994) ranged from poor to very rich (Table 1). SMR and SNR are determined using field-identifiable site and soil characteristics such as slope and slope position, soil texture and coarse fragment content, soil depth, soil color, and presence and type of forest floor and A horizon (Green and Klinka 1994). SMR has been related to measurements of soil water balance (Giles et al. 1985); SNR has been related to concentrations of available nutrients (Kabzems and Klinka 1987).

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