Viewpoints

By Kevin Brown, PhD, PAg, RPBio

Beyond Nitrogen:

How is Red Alder Growth Affected by Mineral Nutrient Supply?

To many forest professionals in coastal BC, nutrient supply is synonymous with nitrogen supply. Early research showed that the growth of commercially important conifers in the region was more often limited by nitrogen than by other mineral elements. Regional forest nutrition research has since emphasized nitrogen.

However, red alder supplies much of its nitrogen requirements by atmospheric nitrogen-fixation. It returns that nitrogen to the site over time, possibly increasing site productivity. This raises some questions:

- Is growth of alder limited by supplies of elements other than nitrogen?
- Are nitrogen-fixation and accumulation limited by supplies of other elements?
- What growth responses result if nutrient deficiencies are eliminated?

Determining what elements limit growth and to what degree is complicated. At least 14 elements can limit plant growth. The amount and combinations of nutrients added, combined with the type of data collected, can affect an experiment's results and alter the perception of what elements limit tree growth.

Studies in the early 1990s indicated that site index of alder on Vancouver Island increased with phosphorus availability, more so than with other elements. Based on that, we initiated experiments (through the Ministry of Forests Research Branch) to clarify how growth of young alder responded to the availability of phosphorus and other elements. We began with seedlings in glasshouses, then progressed to short-term single-tree plot and later to longer-term multi-tree-plot field experiments. Soil and foliar nutrient concentrations were determined so that treatment effects on growth could be better understood.

Phosphorus was applied as triple super phosphate (0-45-0), a commonly used phosphate fertilizer, with or without other elements. In field studies, fertilizer was placed or banded near each tree, generally within a year of planting. Growth increased at application rates up to 30 g of phosphorus per tree for trees fertilized within a year of planting, as did foliar phosphorus concentrations. Growth did not increase with additions of elements other than phosphorus, nor when tree were first fertilized more than two years after planting.

Growth responses to phosphorus additions have been substantial (Figure 1). Through three years, responses were consistent across a range of sites. Through five to six years, phosphorus additions at planting on fresh-moist sites increased heights by 11-14% (0.7-0.9 m) and dbh(diameter at breast height) by 14-17% (1 – 1.1 cm). Individual-tree basal areas increased 27-35% (11-15 cm^2 per tree).

Phosphorus additions initiated the year following planting on a moderately-dry site near Bowser, 70 km north of Nanaimo, increased tree basal area by 40% (20 cm^2 per tree) through nine years (Figure 1). However, basal areas of 'crop' trees (the largest 400 trees per ha) did not increase with phosphorus additions. (Treatments at Bowser differed from other sites in that phosphorus was initially added at lower rates and then added again in years 2, 3, 4 and 6; however, effects of phosphorus additions were established by the initial fertilization).

Although deficiencies of phosphorus for alder clearly occur, other elements may be deficient on some sites. Phosphorus additions have also increased foliar nitrogen contents. Does increased phosphorus availability increase long-term site nitrogen availability?

How long the effects of phosphorus additions will persist is unknown. So maintenance and remeasurement of these existing studies are crucial. Density-dependent mortality has not yet begun in our plantations. Will faster-growing phosphorus-fertilized plots begin to self-thin before unfertilized plots? What implications will that have for stand growth?

At our moderately dry site, the effect of phosphorus additions on annual basal area increment may have increased with growing-season precipitation. However, data are available for only six years (Figure 2) and there are presently more questions than answers. Understanding the interaction between moisture and phosphorus availability matters because changing climates may affect growing season moisture availability and growth of alder on some sites.

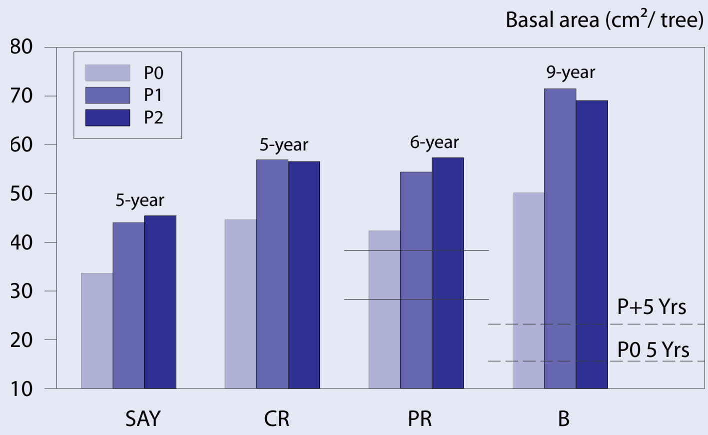

Figure 1 *Cumulative individual tree basal areas of alder fertilized with phosphorus. Sayward (SAY), Campbell River (CR), and Powell River (PR) sites were fertilized shortly after planting with 0, 30, or 60g phosphorus per tree; Bowser (B) site was fertilized one growing season following planting, initially at 0, 15 or 30g phosphorus per tree, and subsequently in years two, three, four, and six.*

Many of our study sites were classified as 'rich' or 'very rich' but experiments showed that sites were deficient in phosphorus for young alder. Phosphorus additions increased growth when foliar phosphorus and soil extractable phosphorus concentrations were less than about 0.2% and 15 parts per million, respectively. Site classifications for alder may benefit from soil or foliar analysis for phosphorus.

Fertilization of alder at planting has rarely been examined in operational studies, but the results were consistent with these data. Additional trials could define what sites are appropriate for treatment, what other elements might limit growth, and what sources for nutrients are most suitable. This information is important. Supplies of traditional fertilizer sources of phosphorus are limited and phosphorus fertilizer manufacture and overuse has significant environmental impacts.

Alder has a unique suite of ecological and product characteristics and should be better understood and utilized in coastal BC. Phosphorus deficiencies can limit the growth of young red alder and phosphorus additions at planting can increase growth for at least several years thereafter. Many questions remain. Answering those questions demands continued predictable support for silvicultural research. ❧

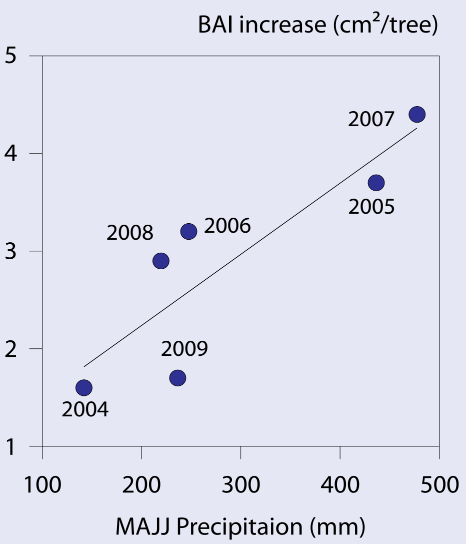

Figure 2. *Increase in current basal area increment (BAI) from phosphorus fertilization with early growing-season precipitation (March, April, June, July) at the Bowser site. May precipitation was not correlated with BAI response.*

Kevin Brown, PhD, PAg, RPBio, consults from Victoria (www.cfbc.bc.ca). He's studied forest regeneration, physiology and nutrition from Alaska to Oregon and east to Ontario. He has a special fondness for hardwoods. E-mail: treenutrition@gmail.com.

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