Variability of Crop Tree Response to Fertilization in Unspaced Douglas-fir Stands – FRDA Report 085

Due to the uneven distribution of volume classes and the subsequent potential for timber supply shortages in many coastal timber supply areas, silviculturists are very interested in intensive practices that can shorten crop tree rotation length and thereby bring second growth stands to rotation. This study examines the magnitude and variability of crop tree response to fertilization with 225 kg ha⁻¹ of nitrogen as urea in unspaced stands of immature coastal Douglas-fir after a minimum of 8 post-treatment growing seasons in 3 stands, Courtenay, Morton, and Sayward on eastern Vancouver Island.

The stands are in the CWHxm and CWHdm biogeoclimatic subzones. The Courtenay site is nutrient poor and moderately dry. The Morton site is poor to medium with respect to nutrients and slightly dry, and the Sayward site has a medium soil nutrient and moisture regime. All 3 stands were fertilized by helicopter using a nominal rate of 225 kg N ha⁻¹ as urea (46-0-0). Both height and diameter of all trees larger than 7.5 cm dbh were evaluated in ten 0.01 ha plots within each treatment on each site.

STEM ANALYSIS METHODS

Four variables were measured on felled trees:
1. total tree height and height to the base of the live crown
2. length of the longest live branch at the base of the live crown
3. diameter outside bark at breast height
4. annual height increment for each of the past 15 years.

Cross sectional disks were taken at stump height (30 cm), 60 cm, breast height (1.3 m), and at 3 evenly spaced intervals along the remainder of the stem to a 7.5 cm top. These disks were sent for laboratory measurement of ring widths.

CONCLUSIONS

The sample size was evaluated using the matrix determinant method. This evaluation showed that the standard error became relatively small and stable for sample sizes greater than 10 to 15 trees on all sites. A sample size of 30 trees per site was used in this study.

Stem eccentricity sometimes had a profound influence on radial increment measurements.

Sampling should be taken at heights greater than 4 meters and at least 2 transects should be measured on each cross-sectional disk to reduce measurement error due to stem eccentricity.

Fertilization significantly increased height growth of crop trees for 3 to 4 years although the effect was quite small and variable.

Unequal pre-treatment volumes made comparison of fertilizer effects difficult. Annual volume increment was adjusted on the Morton and Sayward sites so that the pre-treatment volumes for both the fertilized and control trees were equivalent.

Fertilization significantly increased the annual volume increment for 4 years on the Courtenay site, 3 years on the Morton site, and 2 years on the Sayward site. The volume gained through fertilization after 3 growing seasons ranged from 1.9 m³ ha⁻¹ (Sayward) to 10.3 m³ ha⁻¹ (Morton).

These values were quite variable and less than values commonly found in research trials on similar sites. The response duration was also less than commonly cited for coastal Douglas-fir on eastern Vancouver Island. The investigators suggest this could have been due to several factors:

- losses through volatilization at the time of application
- high rates of nitrogen immobilization
- poor uptake by the trees
- competition for moisture and/or light in these densely stocked stands or
- possibility that nitrogen was not significantly limiting growth on the study sites.

Fertilizer efficiencies, defined as cubic meters of stem wood produced per kg of nitrogen applied, were quite low compared to results from the Shawngigan Lake fertilizer trials. Fertilizer efficiencies ranged from 0.009 (Sayward) to 0.048 (Morton) m³ kg⁻¹ N⁻¹. Foliar biomass cannot increase following fertilization as a result of crown competition, increased rates of

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growth will only continue as long as foliar nitrogen levels are elevated above control levels, often only 2 to 4 years in coastal Douglas-fir ecosystems. The relatively short-term growth response found in the stands examined in this study suggest that fertilization should be carried out not more than 10 years before rotation for a favourable economic response.

Only a small amount of the total variation in annual volume increment could be attributed to fertilization. Moisture availability during the growing season, during June in particular, accounted for up to 76% of the variation in annual volume increment. Live crown length and pre-treatment volume accounted for much of remaining variation in annual volume increment. These data suggest that espacement practices that increase mean stem diameter, encourage crown development, and reduce competition for moisture may be more effective tools for increasing crop tree volume growth than fertilization of unspaced stands. Taking advantage of synergistic effects between thinning and fertilization is suggested to be the best method for enhancing the growth of crop trees.

The simple rate of return on the fertilizer investment 8 years after treatment ranged from -4.9% to 15.1% with fertilization costs of $150 ha$^{-1}$ and the value of the extra wood estimated to be $45$ m$^3$.

The high significance of pre-treatment volume as a covariate with treatment was consistent with other studies and suggests that the greatest fertilizer response occurs on the largest trees as a result of positive current annual increment interaction. Consequently, the author recommends that stands that do not have well established dominants should not be fertilized or should be spaced prior to fertilization.

Copies of the 12-page report, *Variability of Crop Tree Response to Fertilization in Unspaced Douglas-fir Stands* by Reid Carter, are available while supplies last from:

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Please quote FRDA Report No. 085 when ordering.