# RESEARCH NOTE

No. 77

1976



# FIVE-YEAR GROWTH RESPONSE OF DOUGLAS-FIR TO FERTILIZATION IN THE SAYWARD FOREST, VANCOUVER ISLAND



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E.P. 678

## ABSTRACT

The initial five-year basal area growth response of fertilized Douglas-fir plantations in the Sayward Forest was statistically analysed. Heavier applications of urea fertilizer were found to result in proportionately greater basal area growth on most soil types. The addition of other nutrients to the N224 urea application did not produce significantly more growth. The potential usefulness of soil stratification for assessment of fertilizer-induced growth response was demonstrated.

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## INTRODUCTION

In 1966, Cominco Limited, in cooperation with the Research Division of the B.C. Forest Service[1] established a series of plots to determine the effect of fertilization on tree growth. Plots were located in low elevation Douglas-fir plantations in the Sayward Forest near Campbell River on Vancouver Island, within geographic coordinates 49°55' to 50°01' N., and 125°11' to 125°31'W. The experimental objective was to demonstrate possible growth responses to applications of urea and other added nutrients and to investigate the possible usefulness of soil stratification for fertilizer prescriptions. This paper reports the basal area growth response to fertilization for the five-year period following treatment.[2]

## METHOD

Five experimental blocks were established, each block representing a different soil type and each consisting of a systematic layout of 20 plots. All five soil types were described in detail by Keser (1969). Table 1 presents the stand statistics before treatment according to soil type.

Table 1. Stand Statistics before Treatment

| Soil type | Age (years) | Site Index (m @ 50 years) | Stand Density (stems/ha) |
|---|---|---|---|
| Hart, outwash gravel | 28 | 17.1 | 1450 |
| Senton, outwash sand | 25 | 24.4 | 1650 |
| Gosling, volcanic-rich till | 23 | 25.0 | 1680 |
| Quinsam, sandstone-rich till | 23 | 25.0 | 1540 |
| Memekay, marine clay | 27 | 28.3 | 1260 |

[1] Under direction of Dr. J. D. Beaton of Cominco and the late Dr. Nurettin Keser of the Research Division, B.C. Forest Service.

[2] Detailed records of the experiment (E.P. 678) are stored in the Research Division, B.C. Forest Service.

These stands were originally planted at a 2 x 2 m spacing (2500 stems/ha) but these densities were subsequently reduced by natural mortality to the lower values observed at the time of treatment (Table 1).

Individual plot size was 0.02 ha in the Hart experimental block and 0.04 ha elsewhere. Buffer strips of 10 m width were located between the plots.

In the fall of 1966, treatments were assigned at random to plots within each experimental block. Nine treatments were replicated and two were unreplicated as shown in Table 2. Fertilizer treatments were hand-broadcasted on each sample plot. All trees in the sample plots with diameters at breast height greater than 7.5 cm were measured to the nearest 2 mm in 1966 and 1971.

Table 2. Summary of Plot Treatment

| Code | Treatment[1] |
|---|---|
| NO | Control - no treatment |
| N1 | N112. urea. |
| N2 | N224. urea. |
| N3 | N336. urea. |
| N4 | N448. urea (unreplicated). |
| +S | N224 S90. Ammonium sulphate and urea. |
| +Mg | N224 S90 Mg112. Magnesium sulphate, magnesium nitrate and urea. |
| +K | N224 S90 Mg112 $K_2O$ 112. (treatment "+Mg") and potassium nitrate. |
| +P | N224 S90 Mg112 $K_2O$ 112 $P_2O_5$224. (treatment "+K") and 11-48-0. |
| +MI | (treatment "+P") and micronutrients |
| +KMg | N224 S90 $K_2O$ 90 Mg 45. urea and K-Mag (unreplicated). |

[1] Treatment numbers show type and amount of fertilizer applied in kg/ha.

## RESULTS

The average pre-treatment basal area and periodic growth per ha of the trees surviving the five-year period of observation are shown in Table 3.

On average, the Memekay soil supported significantly more pre-treatment basal area per ha, and the Quinsam soil significantly less than other soils. The differences are thought to be primarily a matter of site productivity, confounded by minor differences in age, provenance and stocking histories.

No significant differences in pre-treatment basal area were observed within soil types. Therefore, the observed growth was adjusted to a common initial growing stock level for each soil type by covariance analysis. With only two replicates per treatment, the covariance assumptions of linearity and homogeneity could not be tested, but were assumed to hold over the limited range of adjustment within individual soil types.

Simple comparisons of differences between treatments by least significant differences were considered adequate because the treatment responses were either substantial or very limited (Table 3).

Although N4 was unreplicated, the urea-only treatments resulted in significant growth responses on all soil types. On the nutrient-rich Memekay clay site, the response evidently peaked at the lower levels of application (N1 and N2). On other sites, linear response trends were found to be significant, indicating benefits proportional to the level of application.

With respect to the added nutrient treatments, the common application of N2 was considered to be the control. The only significant response was from the +S treatment on the Senton soil. No definite conclusions could be derived for other added nutrient treatments. Collectively, the predominance of positive responses on the sand (Senton) and till (Gosling, Quinsam) soils, suggests that additives may be more useful on these sites than on poor gravel sites (Hart) or nutrient-rich clays (Memekay).

Table 3. Pre-treatment and Five-year Basal Area Growth of Douglas fir

| Soil type: | Hart | Senton | Gosling | Quinsam | Memekay |
|---|---|---|---|---|---|
| Pre-treatment BA($m^2$/ha): | 15.19 | 17.60 | 18.89 | 12.09 | 28.94 |
| Treatment | Post-treatment five-year basal growth ($m^2$/ha)[1] | | | | |
| NO | 5.00(100) | 5.60(100) | 8.09(100) | 6.46(100) | 4.71(100) |
| N1 | 6.83(135) | 6.72(120) | 8.69(107) | 7.49(116) | 6.53(138) |
| N2 | 7.15(142) | 7.10(127) | 10.21(126) | 8.02(124) | 6.79(144) |
| N3 | 8.50(168) | 9.36(167) | 10.60(131) | 9.36(145) | 4.97(105) |
| N4 | 8.80(174) | 8.99(161) | 11.61(144) | 10.75(166) | 6.43(139) |
| N2 | 7.15(100) | 7.10(100) | 10.21(100) | 8.02(100) | 6.79(100) |
| +S | 7.23(101) | 8.27(116) | 10.26(100) | 8.28(103) | 6.31( 93) |
| +Mg | 8.00(112) | 7.86(111) | 10.40(102) | 8.38(104) | 6.69( 99) |
| +K | 6.73( 94) | 7.66(108) | 10.91(107) | 8.09(101) | 6.75( 99) |
| +P | 7.12( 99) | 7.75(109) | 10.91(107) | 9.05(113) | 6.19( 91) |
| +MI | 7.25(101) | 7.80(110) | 10.67(104) | 9.00(112) | 6.19( 91) |
| +KMg | 6.43( 90) | 7.41(104) | 10.42(102) | 8.70(108) | 6.10( 90) |
| Least Sign. Diff. (p.05) | 1.67 | 0.86 | 0.85 | 1.91 | 1.61 |

[1] Figures in brackets relate post-treatment growth to the controls (100) for the respective soil types. NO is the control for the urea (N) only treatments, and N2 is the control for the remaining treatments.

[2] N4 and +KMg are unreplicated treatments.

## DISCUSSION

Unpublished experimental progress reports as well as the above analysis suggest definite basal area growth responses to urea only treatments, but inconclusive additional response to added nutrients.

The percent basal area growth figures shown in Table 3 appear to be comparable with the results of similar studies undertaken in the Pacific Northwest.

Turnbull et al. (1968) described the results of 25 trials in Washington, which covered a wide range of site, age and stand density. Most of these trials were located in natural stands on gravelly till and glacial outwash soils. The authors found that N336 and N448 applications resulted in 30% and 35% greater basal area growth than the control, respectively. Miller and Pienaar (1973) found that the plots studied by Turnbull et al. (1968) gave 60% less volume response than their own plots in plantations. The authors attributed this difference to variation in spacing between natural stands and plantations. If the results of Turnbull et al. (1968) are increased by 60%, their response would be approximately 48% for N336 and 56% for N448. These adjusted figures compare favourably with the Sayward Forest mean responses of 43% and 67% for N336 and N448 respectively, for all soils.

Mallonee et al. (1974) reported basal area growth increases of 25% for N224 and 30% for N448 in plantations of similar age to those used in this experiment, and located on glacial tills in the Campbell River locality. These results are comparable to the 24-26% response observed on the Gosling and Quinsam tills for the N224 treatment. However, the unreplicated N448 treatment on these soil types resulted in appreciably better (44-46%) growth than that reported by Mallonee et al. (1974). The N336 treatment on the Gosling and Quinsam tills produced results comparable to those of Mallonee et al. (1974) (i.e. 30-45%).

## CONCLUSIONS

Heavier applications of urea fertilizer resulted in proportionately greater basal area growth on all soil types except the Memekay site, where growth response peaked at a low level of application. The addition of various other nutrients to the N224 urea application did not result in significantly greater basal area production. The use of soil stratification in the evaluation of fertilizer-induced growth responses was demonstrated.

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