

**PHOSPHORUS DEFICIENCY IN SECOND ROTATION  
PINES AT RIVERHEAD FOREST: THE MUSEUM PLOTS  
REVISITED  
PART ONE: THE RE-ESTABLISHMENT PHASE**

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**NZ FOREST SITE MANAGEMENT  
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# **PHOSPHORUS DEFICIENCY IN SECOND ROTATION PINES AT RIVERHEAD FOREST: THE "MUSEUM" PLOTS REVISITED**

## **Part One: The Re-Establishment Phase**

by

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### **SUMMARY**

At Compartment 8, Riverhead Forest, a 60 year-old radiata pine forest has since the 1950's until 1995, provided information on tree response to superphosphate. Harvesting of the plots commenced in late 1995 and continued through until early 1996. The site was re-established in 1997 as a "demonstration" area of P deficiency in both "museum" stock (seed from the standing crop) and GF30 cuttings. This report describes fully the approach used to take the Museum plots into their second rotation.

### **Introduction**

In the early 1950's unhealthy pines (planted in the 1930's) at Riverhead Forest were successfully treated with P fertiliser. The decision to proceed with P fertiliser was based on work at the now called "Museum Site" (Compartment 8) where a core experimental design tested the elements P and Zn; the rates of P used were between 2 cwt/ac (25 kg P/ha) and 20 cwt/ac (251 kg P/ha), the former reflecting "agricultural" rates of application, and the latter an attempt to capture a possible rate of application "plateau". Data from these plots provided a landmark for the P nutrition of radiata with the establishment of the need for high rates of application of P (compared with agriculture). The addition of Zn had no effect on growth. Later work in the "AK 286" series examined the specific rate requirements and tested rates between 25 and 250 kg P/ha as well as the effect of various timing of applications of P.

In the early 1990's it was becoming increasingly apparent that the first series of P trials at the Museum site had outlived its usefulness, particularly in terms of demonstrating gross P deficiency. The trees were in excess of 60 years of age and well beyond the stage where P deficiency becomes noticeable in young plantations of radiata pine. The value of continuing the demonstration had become questionable.

In consultation with Carter Holt Harvey Forests Ltd (Lindsay Cannon and Bill Dyck) and with Dr Graham Will, it was agreed that "Museum" site should be retained and managed outside of the normal forest production as an area of unique scientific interest. It is a site of several hectares part of which is unamended with P fertiliser. It has the potential to become a useful demonstration area for P deficiency in young pines, and to compare pine performance across the breeding generations (the original radiata population, GF0, and the current breeding stock), and to allow residual effects of P fertilisation from the first rotation (1930's planting) to the second rotation and beyond.

## Objectives

1. to provide a demonstration site for phosphorus deficiency in young radiata pine as a training/educational tool for young foresters
2. to recreate P deficiency in young radiata pine as it appeared historically in the 1930's (with "unimproved" stock) and to contrast this with P deficiency symptoms in high GF rated stock

## Methods

### (i) Fertiliser Treatments

The layout of the Museum plots is presented in Appendix 1. The plots and the 1950's treatments are shown in the Table below under "Plot identification", "Date Treated" and "Treatment". The "New Treatments" are based on selecting the controls, and pseudo-controls (ie the  $\text{ZnSO}_4$  treatments), and the 251 kg P/ha treatments. The low rates of P addition (c. 25 kg P/ha) had only minimal effects on growth in the first rotation and will not have a significant effect of tree P nutrition in the coming rotation. These plots will not be re-used. Given the limited number of plots available for study into the second rotation, the treatments selected for study will be:

#### Control

No fertiliser applied in the first rotation or applied in the second rotation

#### High rate of P in first rotation (251 kg P/ha)

No further treatment in the second rotation. This treatment will enable the effect of the heavy P application in the first rotation to be studied in second rotation pines

#### High rate of P in the second rotation

Control plots were fertilised at the first rotation rate of 251 kg P/ha

### (ii) Genotype comparison

The site also offers a major opportunity to contrast early unimproved radiata seedlings (seed from cones of the original trees) with high GF stock. Seed was collected from the original plot trees to provide a contrast with improved stock. The GF rating for the "unimproved" stock is designated "GF0+".

### (iii) Experimental Design

Main experiment: examines the 1950's fertiliser prescription (0, 251 kg P/ha) with "unimproved" stock, and contrasts with GF30 stock

$\text{GF}(2) * \text{FERT}(2) * 2 \text{ REPS} = 8 \text{ plots}$

The 2 GF ratings are "0" and 30; the 2 fertiliser regimes are: control, and control + 251 kg P/ha

#### Additional plots are:

- Residual 251 kg P/ha = 3 plots (planted with GF30 stock): this treatment examines the effectiveness of the high rate of super applied 46 years previously;

- 4 cwt super/ac (=50 kg P/ha = 1 plot (planted with GF30 stock): this treatment examines the effectiveness of the low rate of super applied 46 years previously.

Table 1. Plot identification and treatments allocated for the Museum site 1952-1955, and re-allocated for the new treatments. The plots (in **bold**) represent the major comparison with GF and P fertiliser.

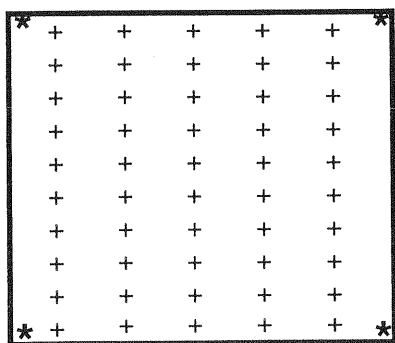
PLOT	DATE TREATED	1950's TREATMENT	NEW TREATMENT
A94	1952	Super @ 20 cwt/ac	residual 251 kg P/ha; GF30
<b>A95</b>	<b>1952</b>	<b>ZnSO<sub>4</sub>, 2.5% spray, 1 pint/tree</b>	<b>GF0; no P</b>
<b>A96</b>	<b>1952</b>	<b>ZnSO<sub>4</sub>, 2.5% spray, 1 pint/tree</b>	<b>GF0; no P</b>
A97	1952	Super @ 20 cwt/ac plus ZnSO <sub>4</sub> , 2.5%, 1 pint/tree	residual 251 kg P/ha; GF30
<b>A97C</b>	<b>1952</b>	<b>Control</b>	<b>GF30; no P</b>
<b>A98</b>	<b>1952</b>	<b>ZnSO<sub>4</sub> crystals, 0.75 lb/tree</b>	<b>GF30; no P</b>
<b>A/160/1</b>	<b>1955</b>	<b>ZnSO<sub>4</sub> @ 1 cwt/ac</b>	<b>GF0; P fert @ 251 kg/ha</b>
A/160/2	1955	Super @ 2 cwt/ac, plus ZnSO <sub>4</sub> @ 28 lbs/ac plus (NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub> @ 56 lbs/ac	<u>not required</u>
A/160/3	1955	Super @ 2 cwt/ac	<u>not required</u>
<b>A/160/4</b>	<b>1955</b>	<b>not used</b>	<b>GF0; P fert @ 251 kg/ha</b>
A/160/5	1955	Super @ 20 cwt/ac	residual 251 kg P/ha; GF30
A/160/6	1955	Super @ 2 cwt/ac plus ZnSO <sub>4</sub> @ 28 lbs/ac	<u>not required</u>
A/160/7	1955	Super @ 4 cwt/ac	<i>single plot observation only; GF30</i>
<b>A/160/8</b>	<b>1955</b>	<b>(NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub> @ 2 cwt/ac</b>	<b>GF30; P fert @ 251 kg/ha</b>
<b>A/160/9</b>	<b>1955</b>	<b>not used</b>	<b>GF30; P fert @ 251 kg/ha</b>
"spare"	1955	not used	<u>not required</u>

The original plots were 20 m by 20 m without treated surround. Since the areas external to the plots were compacted during the "careful" harvest of the original 20 m by 20 m plots these areas were left untreated and unplanted.

#### Location of plots

The plots were identified for long-term maintenance with 10 cm "Rounds" as the corner posts. Posts were established on the original plots to maintain continuity with the fertilised areas. An outline of the re-established "old" plot is shown below in Figure 1.

Figure 1. Layout of re-established plot(s).



\* = original plot pegs; new planting on 2 m by 4 m grid

#### Weed control

Post harvest the entire site was kept weed free using standard CHH herbicide prescriptions. Additional weed control will be exercised throughout the establishment phase and beyond to canopy closure. The details are as follows:

- the entire site was sprayed in 1996 prior to planting
- after planting in July 1997 the entire site was re-sprayed in October/November
- in September 1998 seedlings will be spot sprayed, and the procedure repeated on a yearly basis to control the expected gorse infestation

#### Seedling establishment

Standard CHH cuttings (GF30) and GF0 seedlings (raised at CHH Northland nursery) were planted under careful supervision. The stock was planted at 4 m intervals (across each plot) with 2 metre intervals within lines. Each plot had 50 seedlings per plot.

#### Fertilisation

The relevant plots were fertilised with ordinary superphosphate at the rate of 251 kg P/ha as a broadcast application soon after planting.

#### Pre-harvest soil measurements

From the control and 251 kg P/ha treatments (3 replications) soil samples were taken at 0-10 cm and 10-20 cm at 40 randomly selected locations, and bulked, within each plot. Soils will be analysed for Bray P(1-3), and for total nitrogen.

#### Seedling measurements

Seedlings were assessed for root collar diameter (RCD) and height during October 1997. The data will be used in co-variate analysis when the trees are assessed at age 2 years, 4 years, and beyond. Foliage will be sampled from age 2 onwards during late summer (first sample at age 18 months). Tissues will be analysed for N, P and cations.

## **Appendix 1 - The Museum Plots: selected for re-establishment 1997**

FR 335 RESIDUAL P AVAILABILITY  
Cpt 8 Riverhead Forest CHH Forests Ltd

New plot no.>>  
Original fert / current fert >>  
GF of current stock >>  
Original no. from 1952-55 >>

11  
0/251 P  
GF30  
160/8

8  
25/0 P  
GF30  
160/6

7  
251/0 P  
GF30  
160/5

4  
25/0 P  
GF30  
160/3

3  
25/0 P  
GF30  
160/2

10  
0/251 P  
GF30  
160/9

9  
50/0 P  
GF30  
160/7

6  
0/0 P  
GF30  
98

5  
0/251 P  
GF0  
160/4

2  
0/251 P  
GF0  
160/1

12  
0/0 P  
GF0  
96

16  
251/0 P  
GF30  
94

1  
0/0 P  
GF0  
95

13  
0/0 P  
GF0  
spare

14  
251/0 P  
GF30  
97

15  
0/0 P  
GF30  
97c

Plots 20\*20m (no surrounds)  
2nd rotation established 1997

