Project No. 1841

PROGRESS REPORT ON LEGUMES AND ROCKPHOSPHATE IN NORTHLAND, POTASSIUM NUTRITION ON THE WEST COAST AND BORON TRIALS IN NELSON AND CANTERBURY

by

Alan Nordmeyer

Report No. 28 April 1988

Confidential to Participants of the National Forest Fertilising Cooperative Research Programme.
This material is unpublished and must not be cited as a literature reference.

FRI/INDUSTRY RESEARCH COOPERATIVES

EXECUTIVE SUMMARY

The report describes new work with phosphate rock and legumes in North Auckland. These trials will examine types of legumes, nutrient requirements, and the effect of legumes in the nitrogen nutrition of radiata pine.

Potassium research on the West Coast has shown that K application has uncovered proportions of foliage in the lower Crown. The implications for pruning are discussed.

New work on soil boron tests are reported, and evidence for weeds as serious competitors for Boron is presented.

ROCK PHOSPHATE AND LEGUME GROWTH - NORTH AUCKLAND

BACKGROUND

Radiata pine shows marked yield responses to phosphate fertilisers on some soils in North Auckland. Rock phosphate is currently being used to fertiliser deficient areas. After overcoming basic P deficiencies, nitrogen becomes limiting to productivity with needle N concentrations declining over about 5 years after initial applications of rock P.

Can legumes provide sufficient nitrogen to maintain or increase nitrogen concentrations in radiata pine needles, and as a consequence, increase production?

Co-op members should be under no illusions about finding a quick answer to this question. The reasons are:

1. agricultural use of some of these soils has been limited by the cost of maintaining high inputs of non-nitrogenous fertilisers;
2. legume growth is usually more sensitive to P deficiency than is pine growth;
3. P "fixation" in some North Auckland soils can be very high, thereby lessening the P available for uptake by legumes;
4. use of rock phosphate for the establishment of legumes has not been widely researched in NZ;
5. nutrients not usually in limiting supply for pines can be limiting to some legumes - these nutrients include calcium, molybdenum, sulphur, and potassium;
6. fast-growing legumes have a high demand for soil water during transpiration, perhaps as much as 400 mm per year, and certainly more than radiata pine up to 3 years of age - vigorous legume growth might improve soil nitrogen and needle nitrogen, but depress pine growth through competition for water.

TRIAL ESTABLISHMENT

Bearing these points in mind we have decided, with Northern Pulp and Paper, and with NZ Forest Products, to establish three trials on the Te Pounamu Clays, and on Te Kopuru sand. Each trial involves four levels of rock phosphate (25, 50, 100, 200 kg P/ha) on two legumes (white clover and Maku lotus) with four factors, control, lime, potassium, and sulphur, giving a total of 64 plots for one trial. From these trials we would establish the response of each legume to added P, and the effect of lime, potassium, and sulphur on legume growth. Relevant information will be available by autumn 1989, and the trials will have a useful life of 3 years.

The above trials will involve legumes only.

A second set of two trials will be established on new plantings in spring 1988, to examine the effect of Maku lotus on the growth of *P. radiata.* The latter trials will involve a simple plot layout consisting of P alone, P + lotus, and P + Nitrogen fertiliser, using large plots which can be followed through to monitor tree growth and needle nitrogen concentration over several years.

It is worth noting that Dr Peter Barclay, who did the original breeding of Maku lotus, was trying to develop a plant well-adapted to North Auckland soils. It has proved to be suited to growth in tussock-grassland soils where it has been shown to add about 100 kg N/ha each year to soils over a 20-year period. On Westland pakihi soils Maku lotus also thrived after fertilising with rock phosphate, so much so that it suppressed radiata growth when established before planting. It is for the latter reason that we consider that lotus should not be sown until the pine seedlings are well established. Existing trials in Westland have been set up to examine the best time to establish lotus. Any growth enhancement in radiata pine due to lotus has yet to be proved.

BACKGROUND

Potassium (K) is an essential element for plant growth, and is usually found in highest concentrations in "active" tissues. In radiata pine K concentrations are high in buds, expanding candles, pollen cones, and young needles; concentrations decline as needles age, and also decline towards the base of the canopy. Potassium is translocated from older needles to new growth, and K deficiency symptoms mostly show up in 2- and 3-year needles.

Deficiencies of K have been well known for many years when radiata pine has been grown on soils containing high levels of magnesium; soils developed on serpentine rock in Nelson are an example. More recently, K deficiency symptoms developed in radiata pine on some V-bladed, drained pakihi sites in Westland.

Fertiliser practices have changed rapidly on pakihi sites in the last few years. Major deficiencies of phosphorus have been overcome by applying rock P before V-blading, and by applying DAP by hand soon after planting.

Mike Craw, who has been associated with fertiliser developments on pakihi near Greymouth, reports that on these fertilised stands K deficiency shows up soon after thinning and pruning. Following a period of a few months, most of the needles showing symptoms of K deficiency are shed as litter, and the resultant tree crown appears very open with a predominance of current year needles. Potassium chloride applied to the pruned trees prevents the deficiency symptoms from developing.

POTASSIUM FERTILISERS, FOLIAGE ANALYSES, AND YIELDS

Two trials involving fertilising with KCL have been set up on Timberlands forests in Westland. Trial 407, near Westport, was established to examine K response in young trees before thinning and pruning. K fertiliser raised K concentrations in current needles in the year after application; thereafter concentrations were similar in control and fertilised plots and there was no positive effect of K on yield up until thinning and pruning. This trial has now been abandoned because too few trees remain in some plots to obtain useful measurements after thinning.

Trial 423 at Nemona Forest is again on young trees at the pre-thin stage. No specific effect of K on early growth has yet been detected on trees up to the pre-thin-prune stage.

Needle retention - whole tree harvests

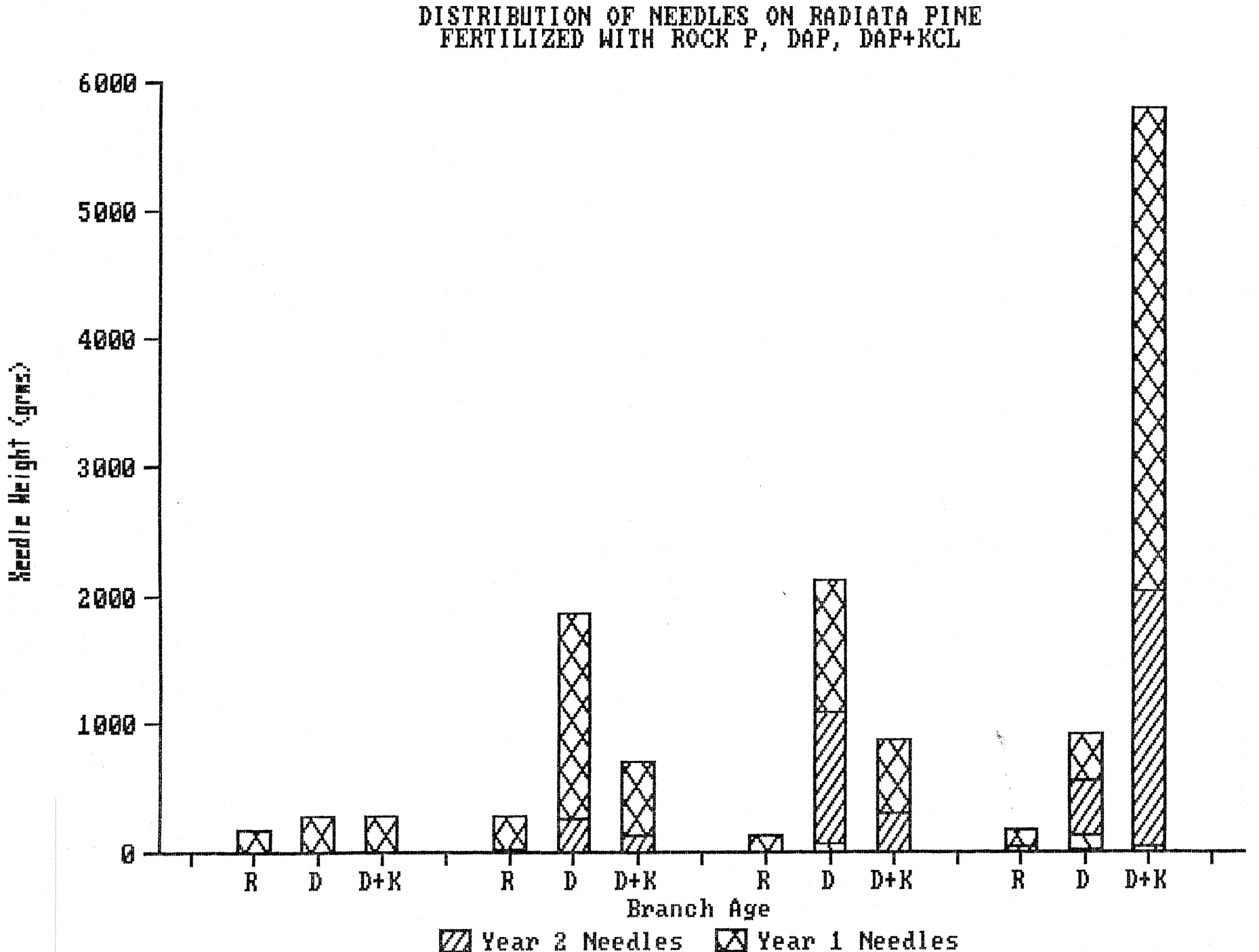
As a consequence of Mike Craw's observations we have harvested trees from different compartments treated with Rock P; DAP - two applications, and DAP - two applications + KCL and weighed components whorl by whorl in order to determine needle distribution by age and by canopy depth. Analyses for K in needles have not been completed but, as shown in the attached graphs, there is no clear evidence that K has increased needle retention, but it does appear that K has increased the proportion of foliage in the lower crown. We certainly need a trial involving K applied after thinning and pruning to check these observations and to determine yield response to K.

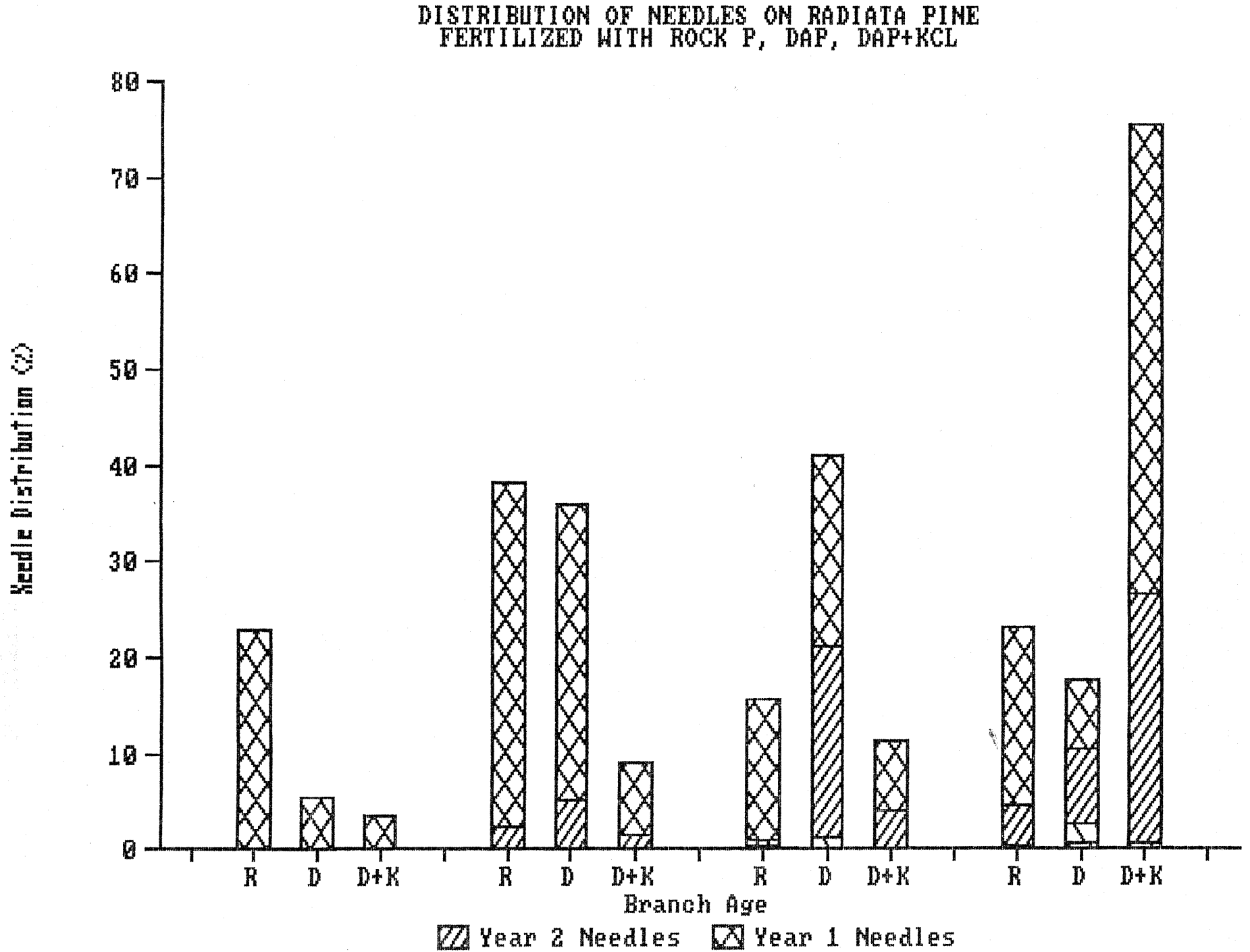
Potassium Leaching

The Larry's Creek catchment study (a V-bladed pakihi site near Reefton) has been extended to include examination of possible K losses after thinning and pruning. The fate of K in thinned and pruned stands is poorly understood; between 25-75 kg K/ha could be returned as slash and there is obviously a potential for K losses if it is not taken up by weeds or final crop trees, or retained in the soil.

Further Potassium Trials

Present trials are inadequate to determine any effects of K on radiata pine yields after thinning. Studies of P and K interactions need to be considered if radiata pine is to be grown on pakihi sites.


DISTRIBUTION OF NEEDLES ON RADIATA PINE
FERTILIZED WITH ROCK P, DAP, DAP+KCL
Needle Weight (grms)
6000
5000
4000
3000
2000
1000
0
R
D
D+K
R
D
D+K
R
D
D+K
R
D
D+K
Branch Age
Year 2 Needles
Year 1 Needles


DISTRIBUTION OF NEEDLES ON RADIATA PINE
FERTILIZED WITH ROCK P, DAP, DAP+KCL
Needle Distribution (%)
80
70
60
50
40
30
20
10
0
R
D
D+K
R
D
D+K
R
D
D+K
R
D
D+K
Branch Age
Year 2 Needles
Year 1 Needles

BORON

Progress report on boron at planting and on boron nutrition.

Boron at planting

Trial FR 24 was established in Baigents Harakeke Forest, Nelson, in spring 1987. The trial involves:

ulexite,	±	weed control
borax		"
colemanite (fine)		"
colemanite (coarse)		"
control (no B)		"

The trial site was root-raked before planting and was largely free of weeds. Bracken and blackberry that came away after planting were sprayed (weed control plots only) in January 1988. Needles have been collected for boron analysis.

Trial 581 Timberlands, Ashley Forest, Canterbury, has been badly affected by windthrow with low numbers of trees left in some plots. Otto Krijgsman and Andy McCord have collected needles for B analysis from the best trees available, but we will need to be cautious in interpreting results as a consequence of the windthrow.

This trial examined a number of different boron fertilisers and it is most unfortunate that it has been damaged. We have discussed with Andy McCord the siting of a new trial, similar to FR 24, to be established in Ashley Forest in spring 1988.

Boron Nutrition

Soil Boron

At earlier co-op meetings we discussed the question of soil boron tests as a potential guide for predicting B deficiencies. We have followed this up by collecting litter topsoil, and subsoil samples from Baigents and Timberlands forests in Nelson, and Timberlands forests near Tapanui. Further soils will be collected from South Island forests over winter.

The soils will be analysed for total B, and for "available" B by the "hot water soluble" method. The latter procedure has not posed any major problems, and from the samples analysed available B is much lower on ridge sites than on mid-slope sites. B is also very low in soils from the Rangiora nursery!

Site Preparation

The question of what is happening to soil nutrients after drastic site preparation is a wide-open question, and one that is immensely difficult to follow through because of soil mixing, downslope soil wash, and windrowing in some cases.

In a trial set up by John Balneaves in Nelson needle B concentrations in 2nd rotation trees were adequate where slash and litter were left on the surface, but were deficient where sites were root-raked.

Shelter Species

A few years ago Nick Ledgard set up trials with different species on the Ministry of Agriculture and Fisheries' farm, Tara Hills, at Omarama. The trials were on irrigated paddocks but, due to water restrictions, irrigation has been curtailed on trees that were initially watered in summer. *P. radiata* now shows classic B deficiency symptoms; alongside Douglas fir has the twisted branch form (described by Wilf Crane at the micronutrient workshop) and Corsican pine, ponderosa pine, and *P. muricata* all have distorted branches and leaders. Boron concentrations (ppm) in foliage were: radiata 6, ponderosa 6, muricata 6, Corsican 5, Douglas fir 10, *Abies alba* 11, Leyland cypress 20, Arizona cypress 24, *Eucalyptus gunnii* 23, *Betula alba* 11, *Alnus glutinosa* 12.

Boron in bracken

Open grown stands of radiata pine form an ideal environment for some weeds. Bracken is one weed that thrives in shade but we know very little about its ability to compete for nutrients with pine. Co-op members maybe interested in some results for one site in Nelson where we analysed boron in bracken from 9 sites. Mean concentrations (ppm) with standard deviations were:

Bracken Leaf	22 ± 1
Stem and Branch	6 ± 1
Standing dead	14 ± 1
Litter (with radiata needles)	11 ± 1

The total amount of boron in the green (annual) bracken fronds was 83 ± 21 gms/ha and exceeded the quantity of B in the current foliage of the radiata pine (c. 50g/ha). Obviously bracken has a high potential to compete with radiata pine for scarce supplies of boron in soil.