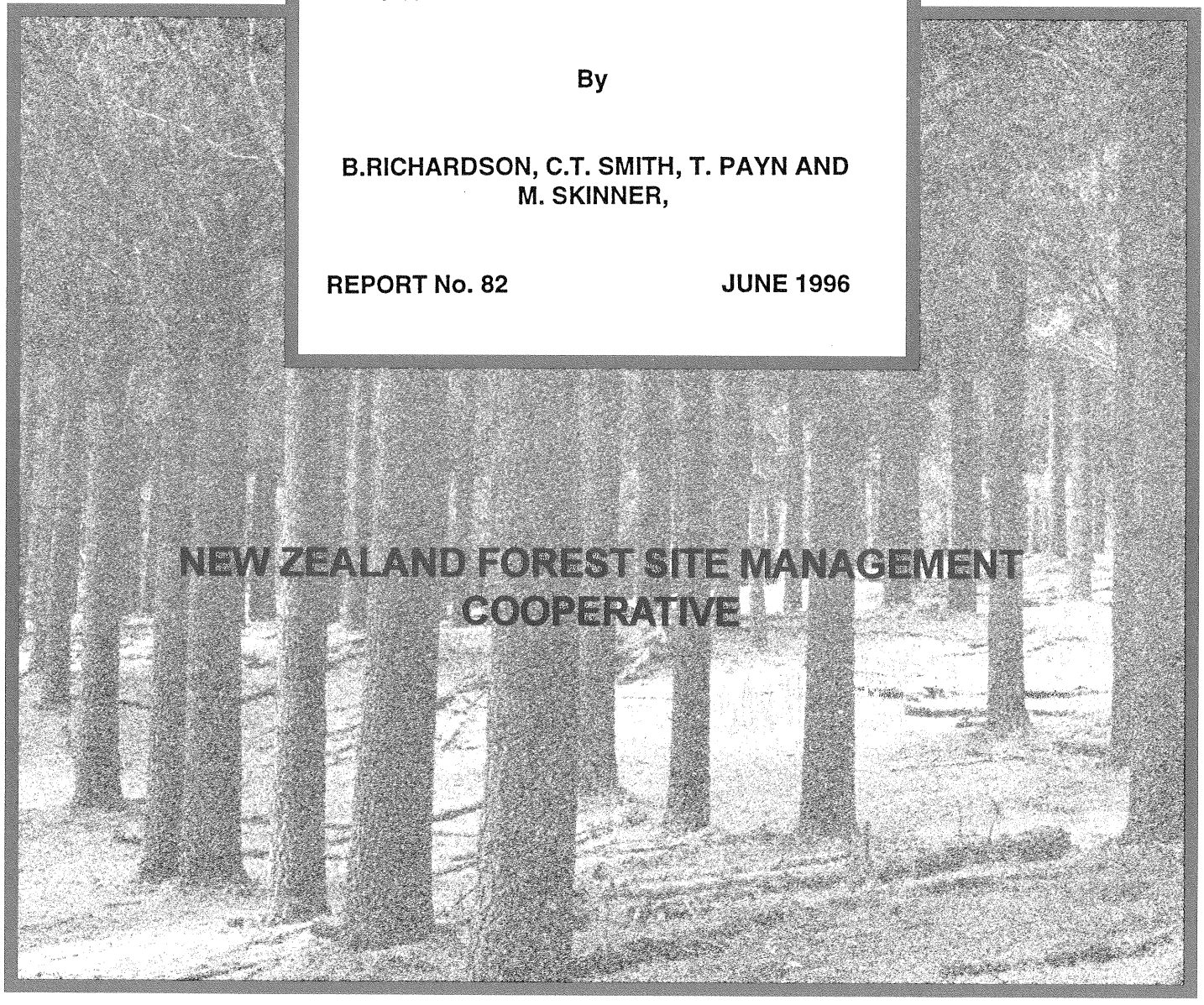
NZ FRI/INDUSTRY
RESEARCH COOPERATIVES

TECHNICAL PRESENTATION NOTES

By

B.RICHARDSON, C.T. SMITH, T. PAYN AND
M. SKINNER,

REPORT No. 82 JUNE 1996



NEW ZEALAND FOREST SITE MANAGEMENT COOPERATIVE

NEW ZEALAND
FOREST RESEARCH INSTITUTE
LIMITED

NZ FOREST SITE

MANAGEMENT COOPERATIVE

TECHNICAL PRESENTATION NOTES

10 JUNE 1996

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6. MAGNESIUM PASTURE AND PRUNING - TIM PAYN

The following notes are copies of the overheads presented during the technical sessions. These are only interim results. Full reports will be written up and forwarded to Cooperative members at a later date.

COMPETITION DATABASE

BRIAN RICHARDSON

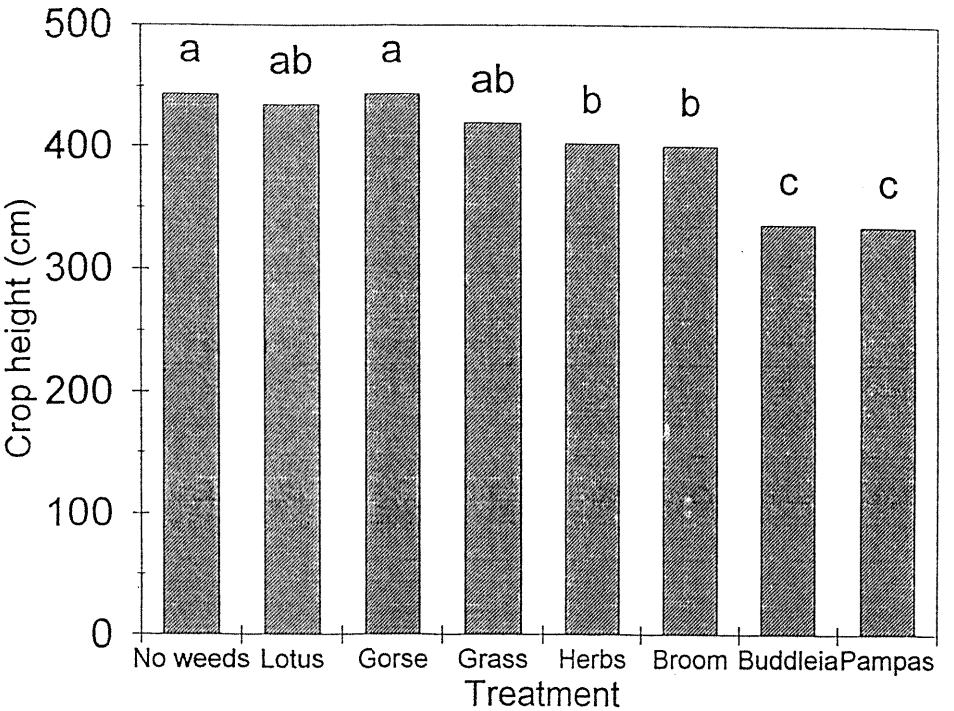
ROTORUA COMPETITION TRIAL

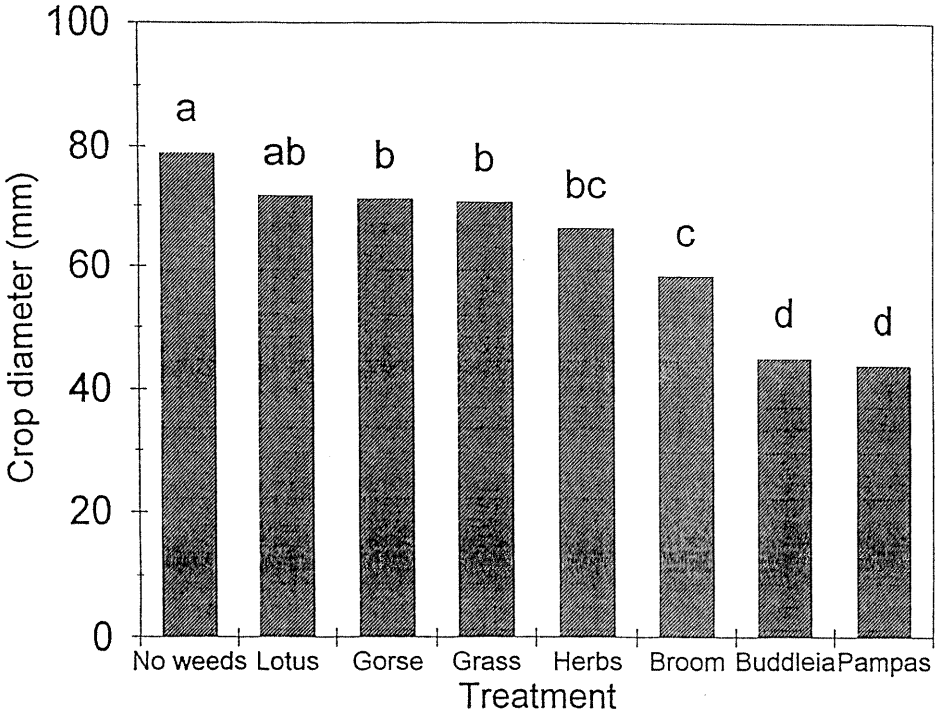
OBJECTIVES:

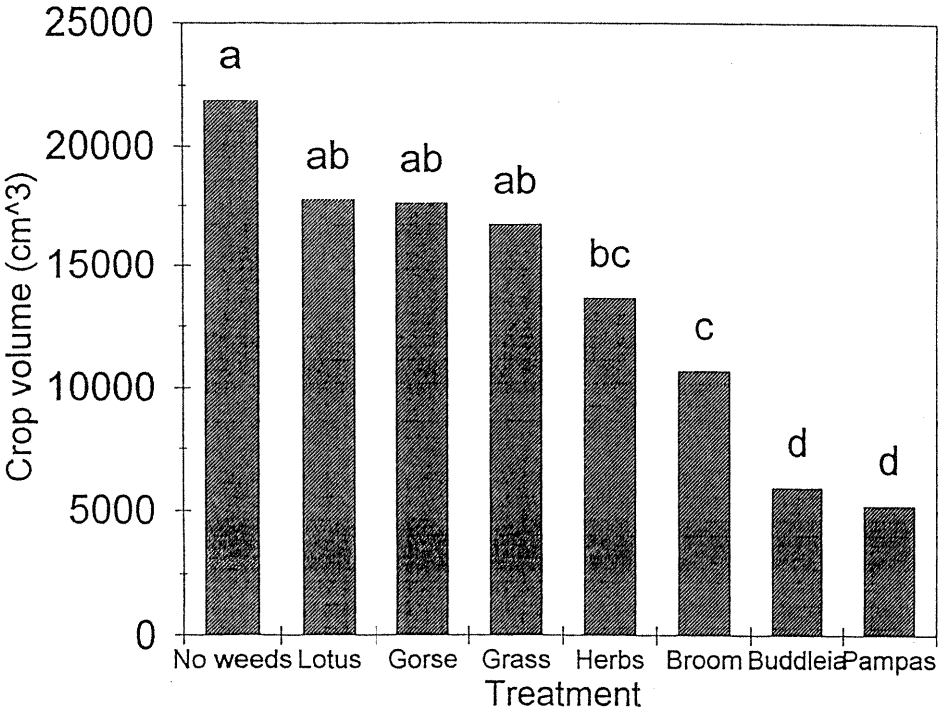
- Effects on pine growth of weed type, nutrient, and water availability.
- Determine mechanisms of competition.
- Determine competitive ranking.

DESIGN:

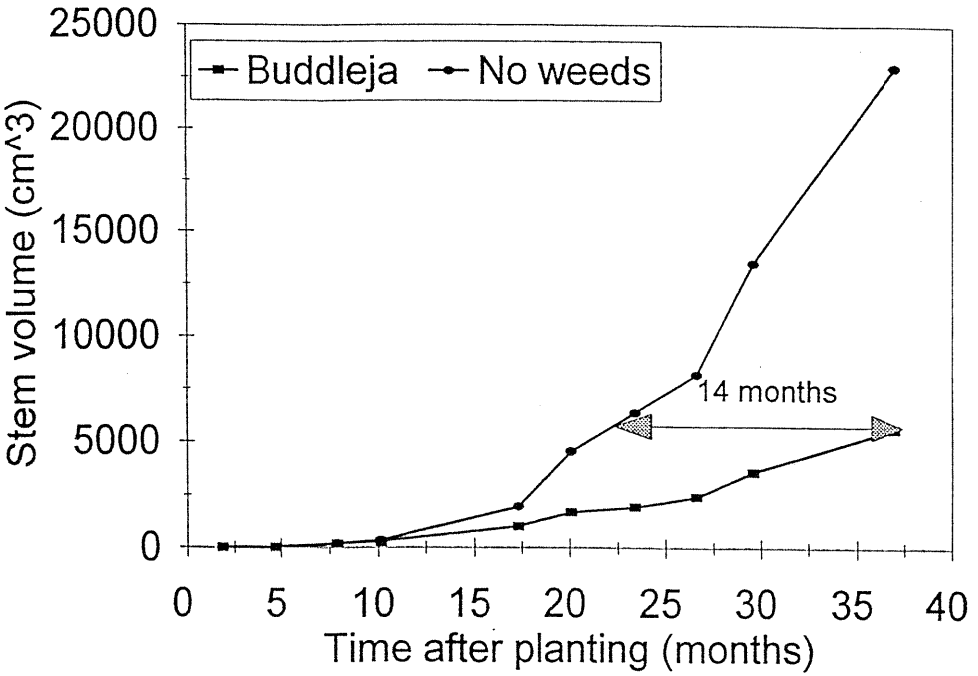
- 3 replications through time
- +/- irrigation, fertiliser
- Buddleia, pampas, gorse, broom, grass, herbaceous broadleaves, lotus, control.




100
80
60
40
20
0
Crop diameter (mm)
a
ab
b
b
bc
c
d
d
No weeds
Lotus
Gorse
Grass
Herbs
Broom
Buddleia
Pampas
Treatment


25000
20000
15000
10000
5000
0
Crop volume (cm^3)
a
ab
ab
ab
bc
c
d
d
No weeds
Lotus
Gorse
Grass
Herbs
Broom
Buddleia
Pampas
Treatment

COMPETITION FOR WATER



. No effect of irrigation on tree or weed growth

. No effect of treatment factors on plant moisture stress, stomatal conductance, or photosynthesis in years 1 or 2.

. Conclude: competition for water not significant.

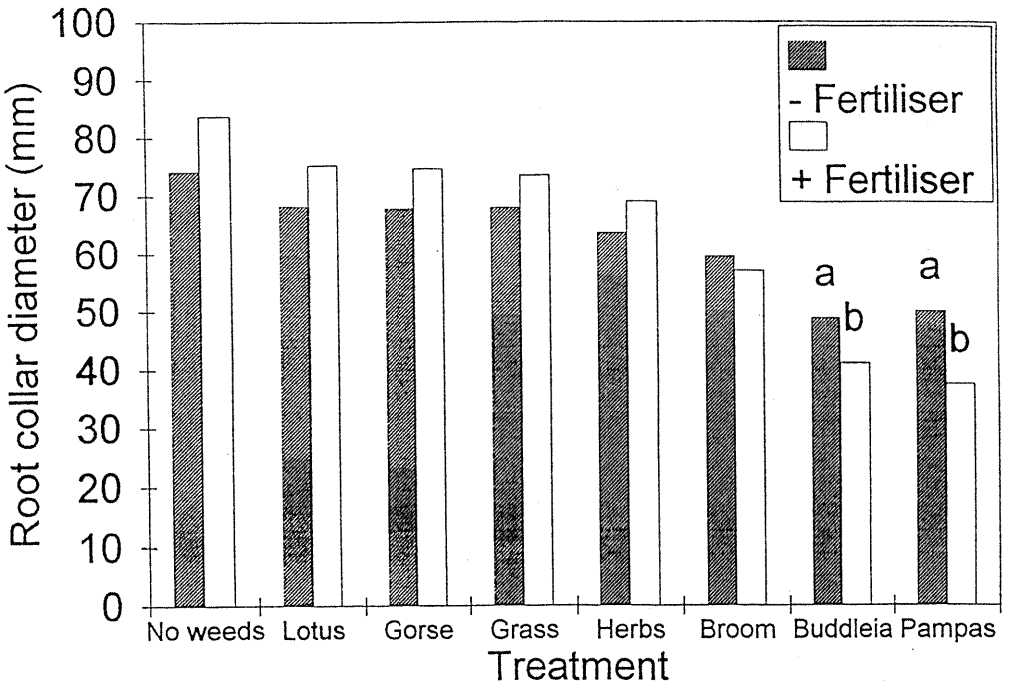
COMPETITION FOR NUTRIENTS

. No main effect of fertiliser on tree growth.

. Significant interaction between weed type and fertiliser on tree growth.

. No consistent treatment effects on radiata pine foliar nutrient concentrations.

. Conclude: growth differences observed in this trial were unlikely to results from competition for nutrients.

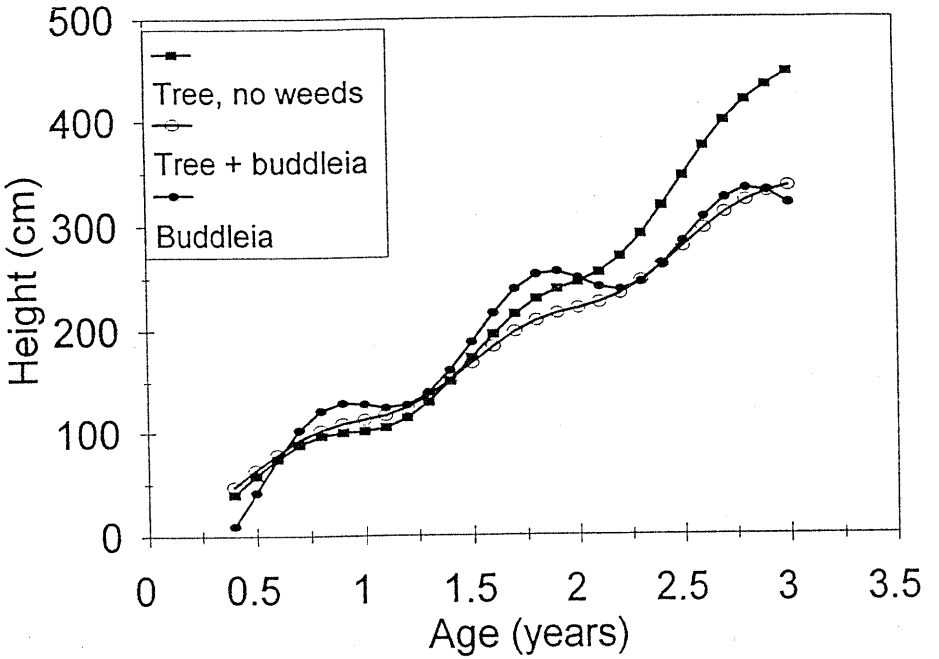


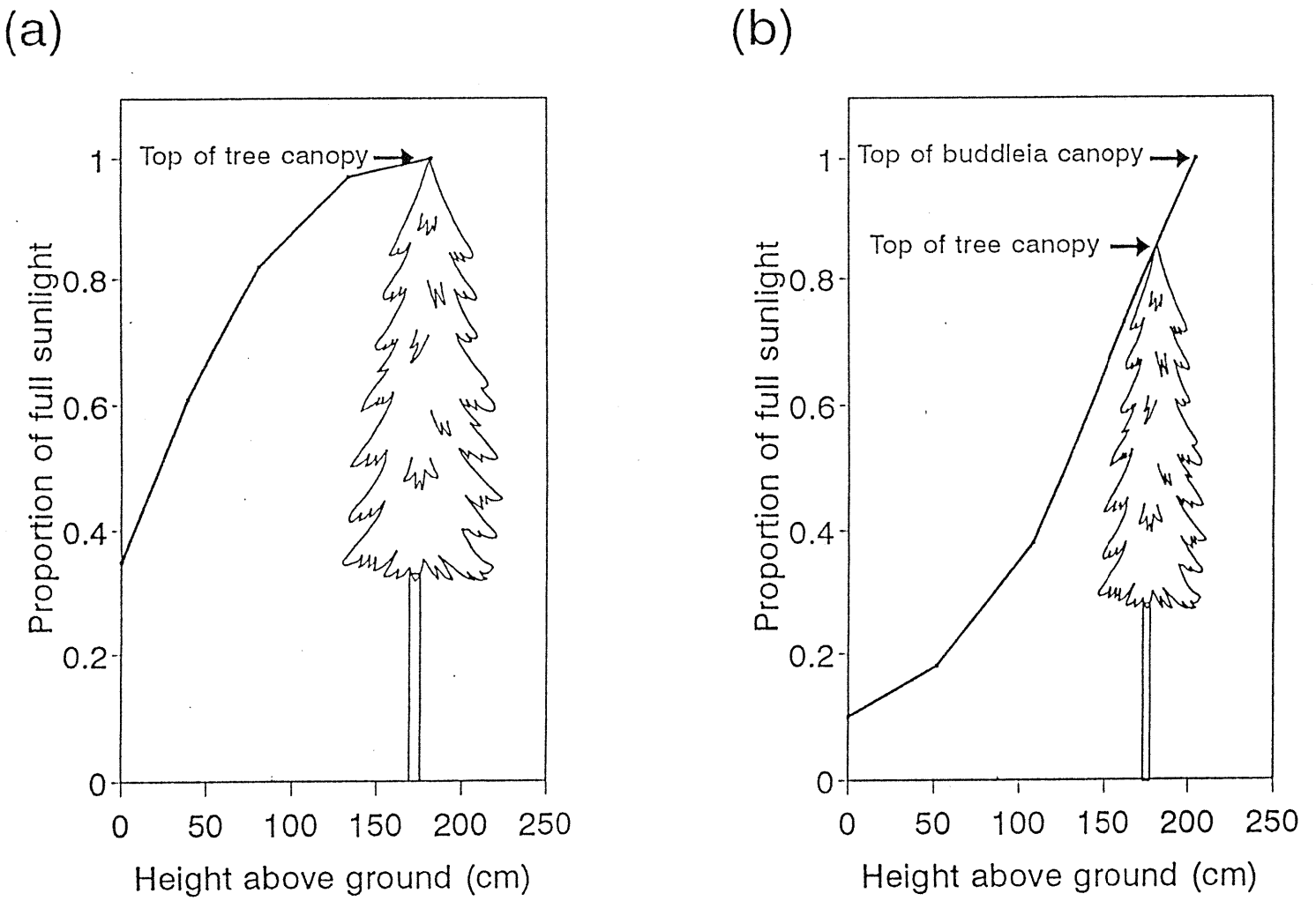
COMPETITION FOR LIGHT

- After 7 months, tall weed species overtopped the trees.

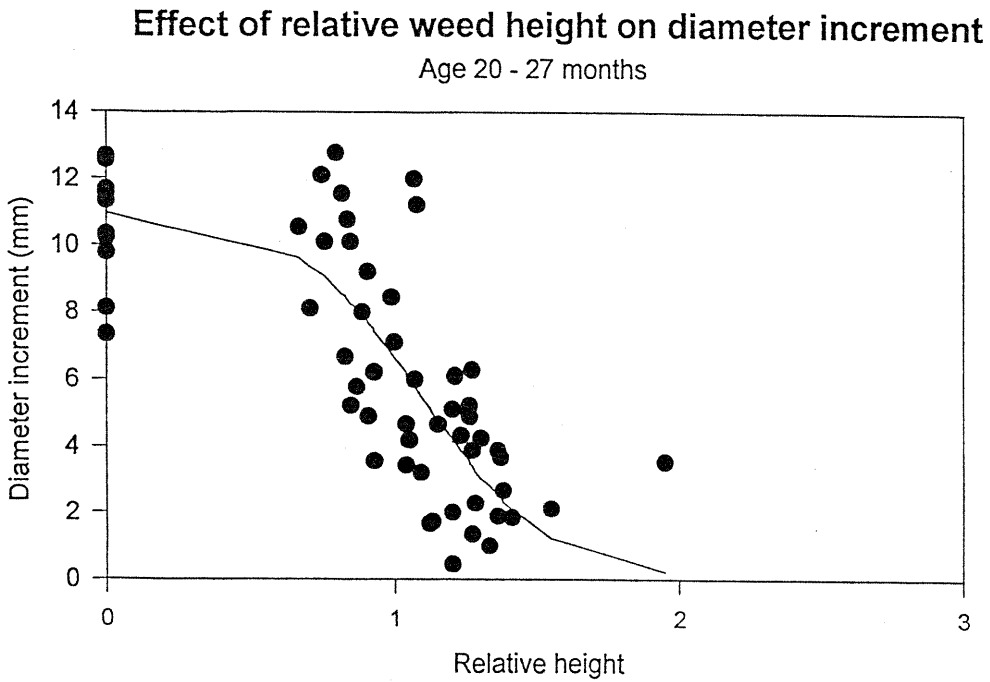
- Effects on growth were proportional to degree of overtopping.

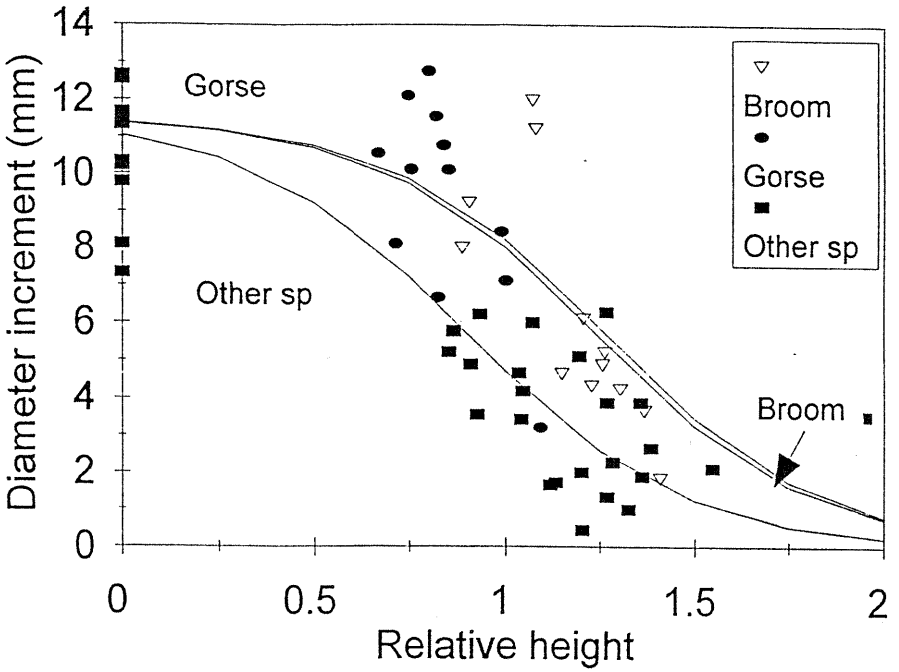
- HYPOTHESIS:
  Shading from weeds caused crop growth losses.





q:\comp\nurcomp\light\cept\
yr3\fig.ch3


Effect of relative weed height on diameter increment
Age 20 - 27 months
Diameter increment (mm)
14
12
10
8
6
4
2
0
0
1
2
3
Relative height


Diameter increment (mm)
14
12
10
8
6
4
2
0
Gorse
Other sp
Broom
Broom
Gorse
Other sp
0
0.5
1
1.5
2
Relative height

CONCLUSIONS

. On moist, moderately fertile sites competition is primarily for light.

. Vegetation management should be targeted to ensure weeds do not overtop P. radiata.

. A distinct competition threshold exists.

. Identity of weed species was not critical.

SITE PREPARATION LITERATURE REVIEW

TAT SMITH

Forest Site Management Cooperative

A Literature Review Of Mechanical Site Preparation Relevant To New Zealand

C.T. Smith, J.A.C. Hunter-Smith, and J.D. Graham

Objectives:

- determine quantitative information available on the effects of site preparation on plantation survival, growth and harvest volume and value to derive cost-benefit relationships for a full rotation of radiata pine in New Zealand; and

- identify gaps in knowledge required for cost-benefit analysis.

Full project included:

- completion of a literature search
- development of an annotated bibliography
- synthesis of current knowledge

- survey of New Zealand forest industry to identify current site preparation practices (Hall, 1996).

Advisory committee:

Coop Member companies: E. Birk, R. Reid, P. Stevens

Research contributors: G. Will, P. Hall, R. Simcock and M. Skinner

METHODS

Electronic and manual search:

- New Zealand published literature, research reports, G. Will report
- international literature

- TREE CD (SilverPlatter International N.V.)
  forestry-specific literature from 1939-1995
  CAB International in CD-ROM format

- CAB Abstracts in CD-ROM from 1987-1995

CD-ROM keyword combinations:

- site preparation and compaction and forestry
- site preparation and compaction
- site preparation and forestry
- site disturbance
- compaction and forestry

NZ FRI technical records system

- relevant trial numbers
- research programme names
- forest and research staff

NZ FRI keyword search:

- ripping
- bedding
- mounding
- cultivation
- compaction
- site establishment

Downloaded and manually added to a bibliographic software database *Reference Manager*

Literature kept separately:

- site preparation machinery performance and operating costs

- papers not measuring effects on soil, site or tree response

- non-mechanical site preparation techniques, e.g. herbicides and burning.

RESULTS

Information selected to answer a forester's questions:

If an operation is conducted on a certain soil type in a particular forest,

- what effect will it have on soil properties,
- will it have a beneficial effect on the trees, and
- is the operation profitable?

Organised into three sub-sections:

- New Zealand published literature
- Unpublished NZ FRI Project Records and Coop reports
- International published literature

Recorded in up to 21 columns for eight topics:

- site preparation operation
- location
- soil type
- effect on soil physical properties
- effect on soil fertility
- tree response
- benefit-cost estimates
- annotated bibliography reference number

Table 1. Effects of site preparation operations on site quality, tree growth, and cost/benefit ratio.

A. PUBLISHED LITERATURE - NEW ZEALAND

Operation	Location	Soil type	Elev	Effects						Tree response								Weed	Benefit/	Annotated Bibliography
					Soil physical properties			Soil fertility												
			m	Frost	Penetration	Structure	Drainage	Pool	Availability	Species	Survival	Growth early	Stand age	Harvest volume	Form	Rooting	Windfirm	control	cost	Reference ID
Cultivation	Berwick	y-b earth								RP	+	+	5				-			191
"	Glendhu	y-b earth								RP	+	+	5				0			191
Rip	Mt Camel	?								RP			3				0			188
"	Parengarenga	Te Hapua pod-sa								RP	?	0	4							163
"	"	Te Kopuru								RP	0	0	?							163
"	"	Ohia sand								RP	?	+	4							163
"	"	Rangiuru clay								RP	poor	+	4				-			163
"	Shenstone	?								RP			3				0			188
"	Topuni	?								RP			3				0			188
"	Takou Bay	?								RP			5				0			188
"	Waipoua	Te Kopuru pod-sa								RP	+	+	4							343
"	Waitangi	Hukerenui si-lo								RP	+	0	5							343
"	Glenbervie SF Maungatapere	Wharekohe si-lo								RP	+	0	2							343
"	Riverhead	clay			+	+	+			RP	+	+	1, 3			+			na	29
"	Coroglen	clay								RP			1				-			188
"	Tarawera	Tarawera scoria								RP		0	?							362
"	Kaingaroa Cpt 558	Kaingaroa lo-sa			0					RP	(+)	0	7			0	0			189
"	"	Kaingaroa gr-sa			+					RP	+	+	5			+	+			189
"	"	?								RP			3			+	-			188
	Kaingaroa Cpt 1031	?								RP			2, 3				-			188
"	Karioi Cpt 61	pod-yb-lo	960							RP	0	0	6, 9			+	-		nil	188 190
"	Motueka	R-dale hill							(+) N	RP		+	11							204
"	Balmoral Cpt 32, 54, 65	Selwyn Balmoral Eyre								RP	+	0(Cpt32) +(Cpt54) +(Cpt65)	4		na(0)	na(-)	na			138
"	Ashley	ls/gr								RP	0	0	1					required	nil	22
"	Eyrewell	ls/gr	66 - 210		+	+				RP	0	0	8, 2, 11.5		+	+	+			25 246 290
"	Mahinerangi			+						RP	0	+	9							23

CONCLUSIONS

- More than thirty years of site preparation research in New Zealand and overseas has not provided adequate information to derive cost-benefit relationships for site preparation operations for a full rotation of radiata pine

- Most trials were only designed to identify gains up to age 5 years

- Few studies have quantified the effect of site preparation operations on soil physical properties and fertility, and related these effects to tree survival, growth, and form

- Not possible to develop specific recommendations for managing soil-site properties on the basis of diagnostic soil physical properties or threshold values for specific parameters

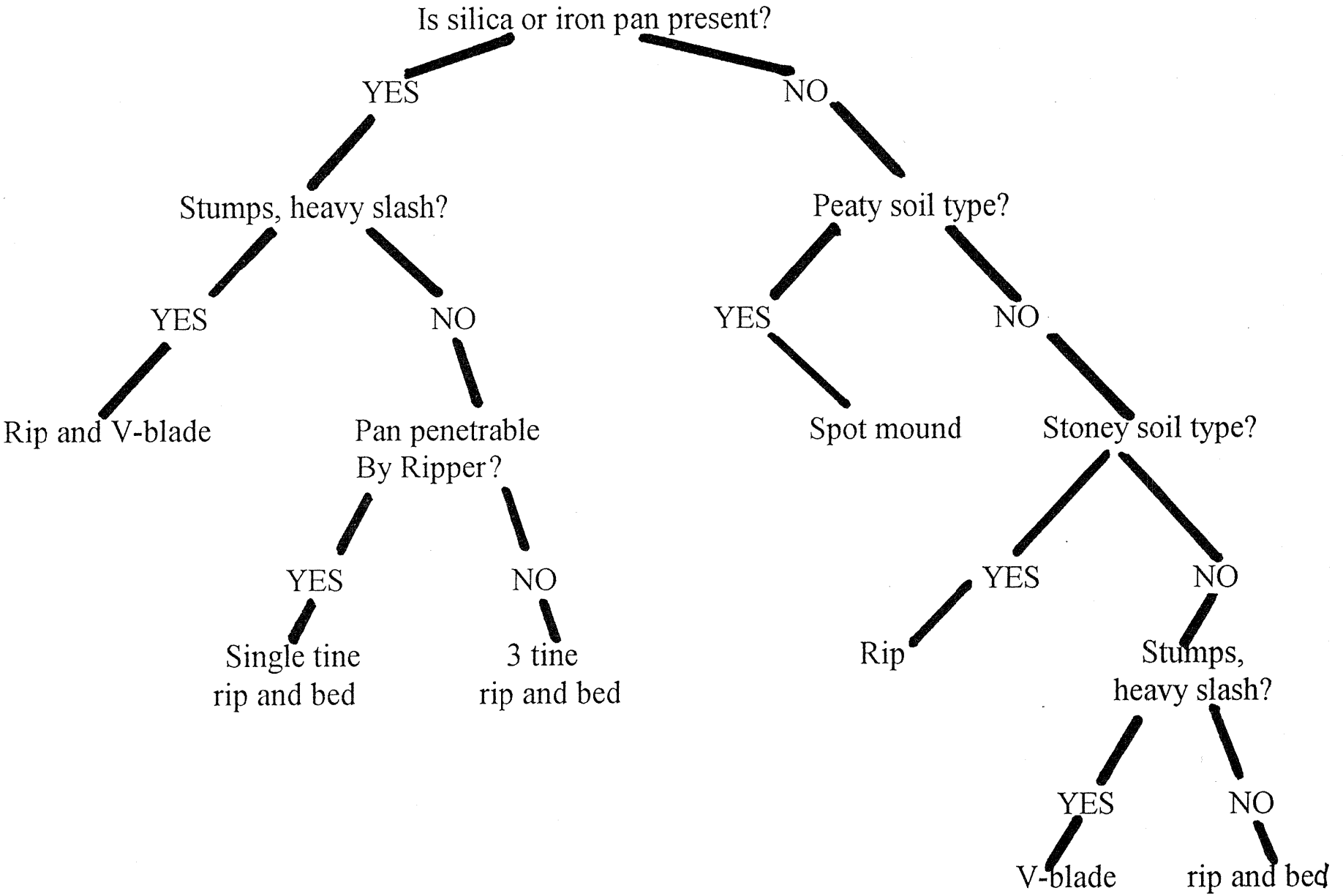
- Cultivation decision chart developed by Williamson (1985) for Northland soils with silica or iron pans is a useful management tool; but should be supplemented with soil physical information concerning the longevity of the effects

- Difficult to predict the efficacy of site preparation operations on soils in regions without case studies, such as the East Cape, Hawke's Bay, and Southland

- Negligible information relating to pastoral sites

- Relative benefits of spot preparations versus linear methods such as ripping or rip-bed operations are poorly understood

CULTIVATION IN NORTHLAND (Williamson 1985)



SOILS "KNOWLEDGE' MATRIX

TIM PAYN

NUTRITION MATRIX - RESEARCH STRATEGY

- NUTRITION PRESENTLY AT WATERSHED WITH A NUMBER OF TRIAL SERIES FINISHING.
- OUR PGSF EMPHASIS IS CHANGING, INDUSTRY RESEARCH INTERESTS ARE CHANGING

TRADITIONALLY - RADIATA, DEFICIENCY CORRECTION

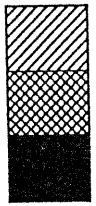
KEY ISSUES IN THE FUTURE PROGRAMME:

- SOIL AND FOLIAGE DIAGNOSTICS
- NUTRIENT SUPPLY AND BALANCE cf DEFICIENCY CORRECTION
- GENETICS
- SPECIES OTHER THAN RADIATA
- LONG TERM FERTILITY TRENDS
- SITE FACTORS/CLASSIFICATION
- MANAGEMENT TOOLS

Current knowledge for management of *P. radiata* nutrition based on past research

Tool/Topic	N	P	K	Ca	Mg	B	Cu	Zn	Mn	S	Al	Fe
Foliar critical levels	√	■	■	√	■	■	■	■	■	√		■
Soil chemical tests	√	■			√							
Site where deficiency expected	■	■	■		■	√	■	■	■			■
Visual deficiency	■	■	■		■	■	■	■	■			■
Fertiliser treatment	■	■	■		■	√	■	■	■			■
Other deficiency indicators					■							
Long term supply implications	√	■			√							
Silvicultural interactions	■	■			■							
Biological inputs	√											
Fertiliser sources		■			■							
Integrated decision support tool available	No	No	No	No	No	No	No	No	No	No	No	No
Further/Continued Emphasis	Yes	Yes			Yes	Yes				.Yes		
Are we happy with the system	80%	90%	90%	50%	80%	60%	90%	90%	90%	30%	No	90%

Darker shading indicates higher confidence in knowledge



Areas we see as important and approximate timing for inclusion in Coop programme

• Phosphate Decision support system 1996/97	Toolbox
• A major emphasis on Boron 1996-1999, and ongoing	Nutrition
• DSS development for N, Mg and B 1997 onwards	Toolbox
• Improvement of N diagnostics 1998/99?	Nutrition
• Continuation of Mg trials 1998 onwards	Nutrition
• Optimum nutrient balance of *P. radiata* and clones 1997-99	Nutrition
• Sulphur (1997?)	Nutrition
• Nutrient balance/cycling/weeds (1997/98?)	Nut/Veg Man
• Site Classification systems (1997 onwards?)	Toolbox

ISSUES:

- TURN EXISTING KNOWLEDGE INTO USEABLE TOOLS. ROUND OUT PAST RESEARCH - P, N, MG, B.

- SOME AREAS WHERE RADIATA KNOWLEDGE LESS THAN COULD BE - CAN DEFINE FUTURE RESEARCH NEEDS - FRAMEWORK

- BORON, SULPHUR, N DIAGNOSTICS

- NUTRIENT BALANCE/UPTAKE EFFICIENCY RADIATA CLONES

- COMPETITION FOR WATER AND NUTRIENTS

- NEED TO MATCH PGSF/COOP/CONTRACT RESEARCH WITHIN OVERALL FRAMEWORK

SOIL TESTING FOR MAGNESIUM, BORON, AND PHOSPHORUS

TIM PAYN
MALCOLM SKINNER

Mg and B Soil Tests

- Mg and B deficiencies widespread
- No soil tests available for predicting susceptible sites
- Such tests would be valuable

Research Proposal

- To investigate soil and foliar relationships for Mg and B
- To develop a useable soil test for predicting deficient sites

Methods

- Sites - Nationwide, range of foliar concs
- Sampling - 15 trees per 0.04 ha plot Current and 1 year needles.
  Needle weight. Unpruned trees. 25 Hoffer soil cores, topsoil depth and bulk density

Methods

- Analytical - Foliar Mg and B concs, weight 50 fascicles
- Analytical - Soil Mg fractionation (soln, exch, acid extract)
- Analytical - Soil B (hot water)
- Statistical - Regression analysis

Table 1. Summary of foliar nutrient concentrations and mass of 100 needles for 1 year (X_1)and 2 year (X_2) needle age classes. Sample population n = 75 for all elements except Ca and K, where n = 71.

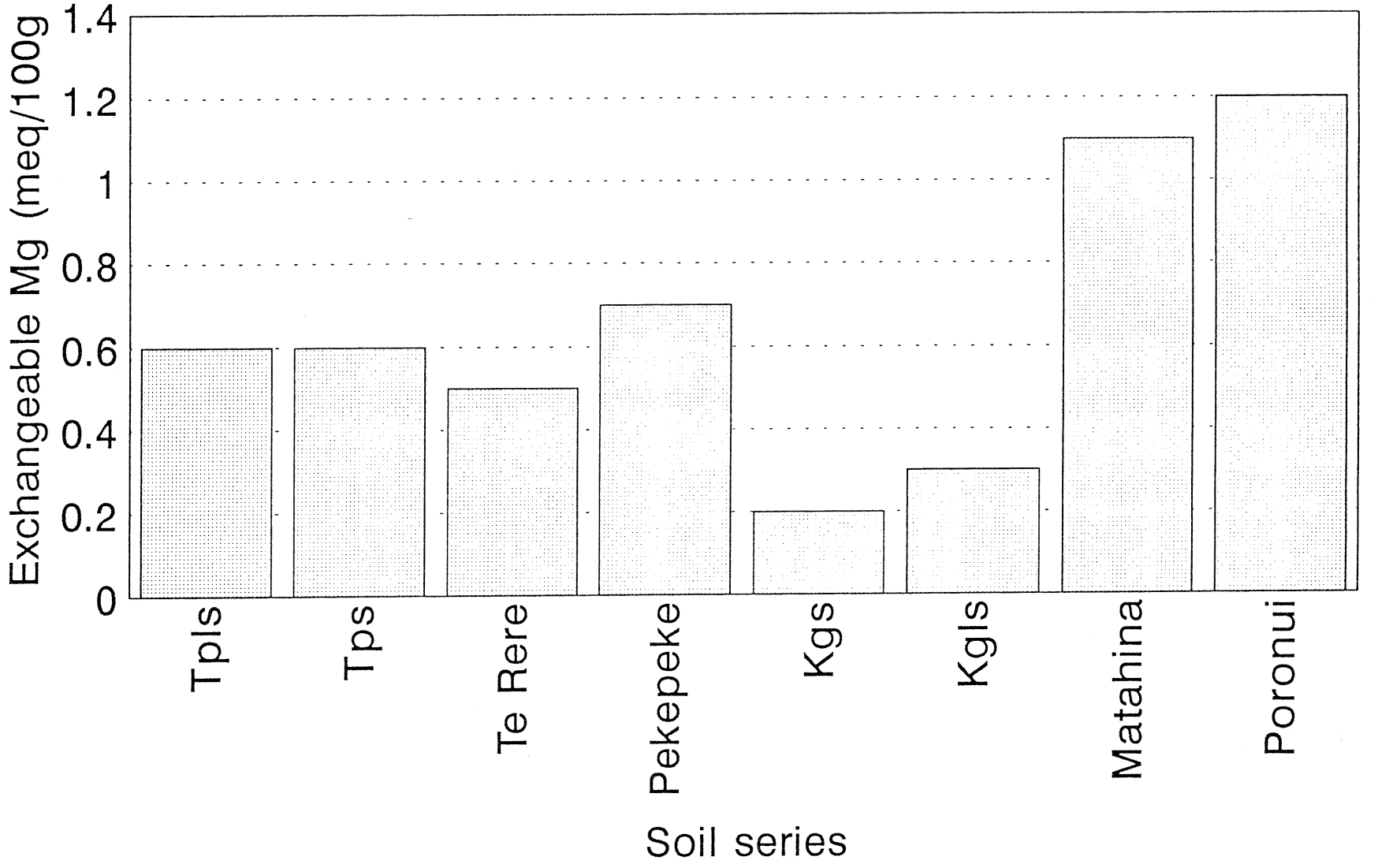
	N_1	N_2	P_1	P_2	K_1	K_2	Ca_1	Ca_2	Mg_1	Mg_2	B_1	B_2	$Mass_1$	$Mass_2$
	(%)										(mg/kg)		(grammes)	
Mean	1.46	1.25	0.152	0.131	0.828	0.679	0.228	0.442	0.096	0.089	15.4	17.3	1.752	2.724
Sd	0.153	0.131	0.0297	0.0300	0.1496	0.1470	0.0565	0.095	0.0199	0.0200	11.9	11.7	0.4008	0.687
Min	1.03	0.99	0.073	0.060	0.458	0.277	0.095	0.179	0.053	0.052	6.0	6.0	0.998	1.154
Max	1.78	1.56	0.215	0.202	1.100	1.057	0.411	0.651	0.128	0.127	58.0	68.0	2.458	5.316

Table 2. Pearson correlation coefficients for foliar nutrient concentrations in 1 year and 2 year needle age classes. Intercorrelations for 1 year foliage in top right block, 2 year age class in the lower left block below the 1:1 line. Probabilities associated with the coefficients are shown in smaller type.

	N	P	K	Ca	Mg	B
N		**0.43190**	0.05481	**0.38943**	-0.05721	**-0.41068**
		0.0001	0.6498	0.0008	0.6259	0.0003
P	0.09294		**0.56513**	**0.31031**	0.18984	0.00483
	0.4227		0.0001	0.0084	0.1028	0.9672
K	-0.04704	**0.46814**		0.00849	**0.28784**	0.21991
	0.6886	0.0001		0.4631	0.0149	0.0654
Ca	-0.13008	**0.23878**	0.17623		**0.28663**	**-0.27566**
	0.2660	0.0391	0.1304		0.0154	0.0200
Mg	-0.10904	**0.25385**	**0.33863**	0.01397		-0.10989
	0.3517	0.0280	0.0030	0.9053		0.3480
B	**-0.25903**	0.12861	**0.34361**	-0.15440	0.14811	
	0.0248	0.2715	0.0025	0.1831	0.2048	

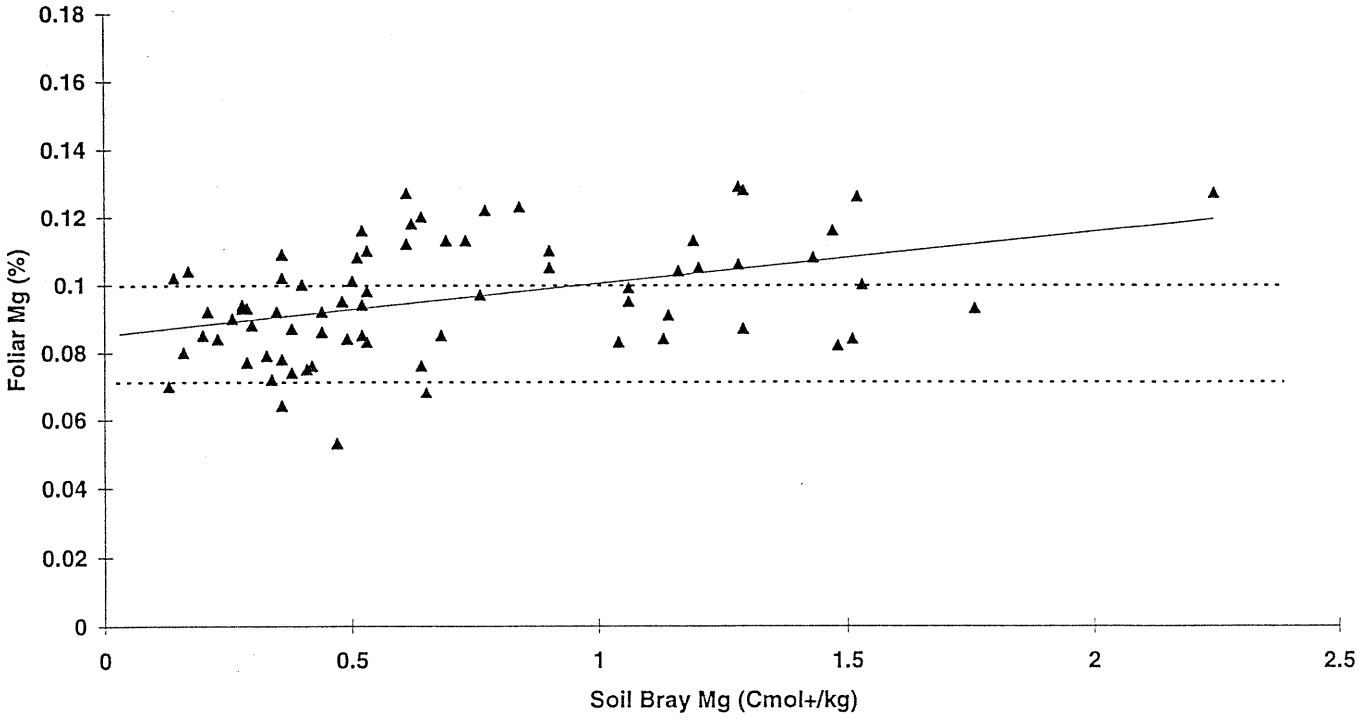
FIG. 4.

Variation in exchangeable Mg with soil series

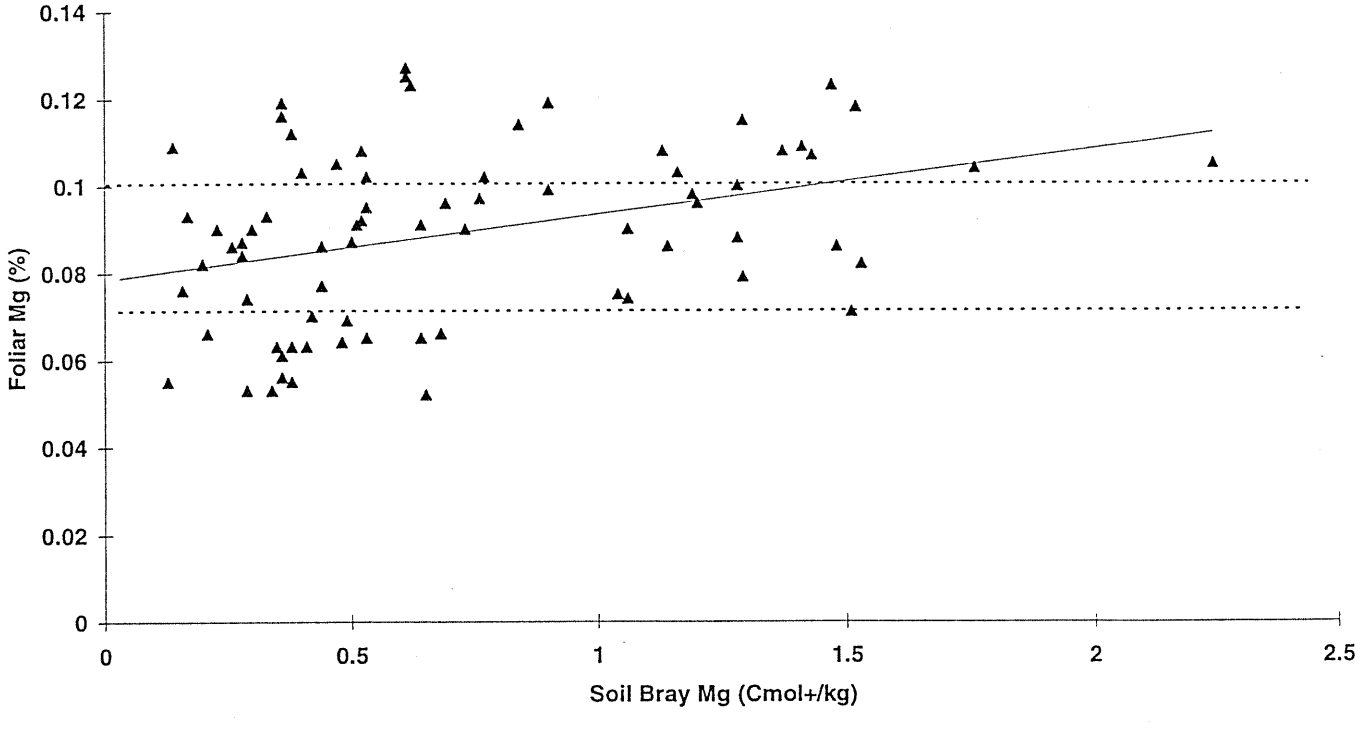


After Rijkse 1988

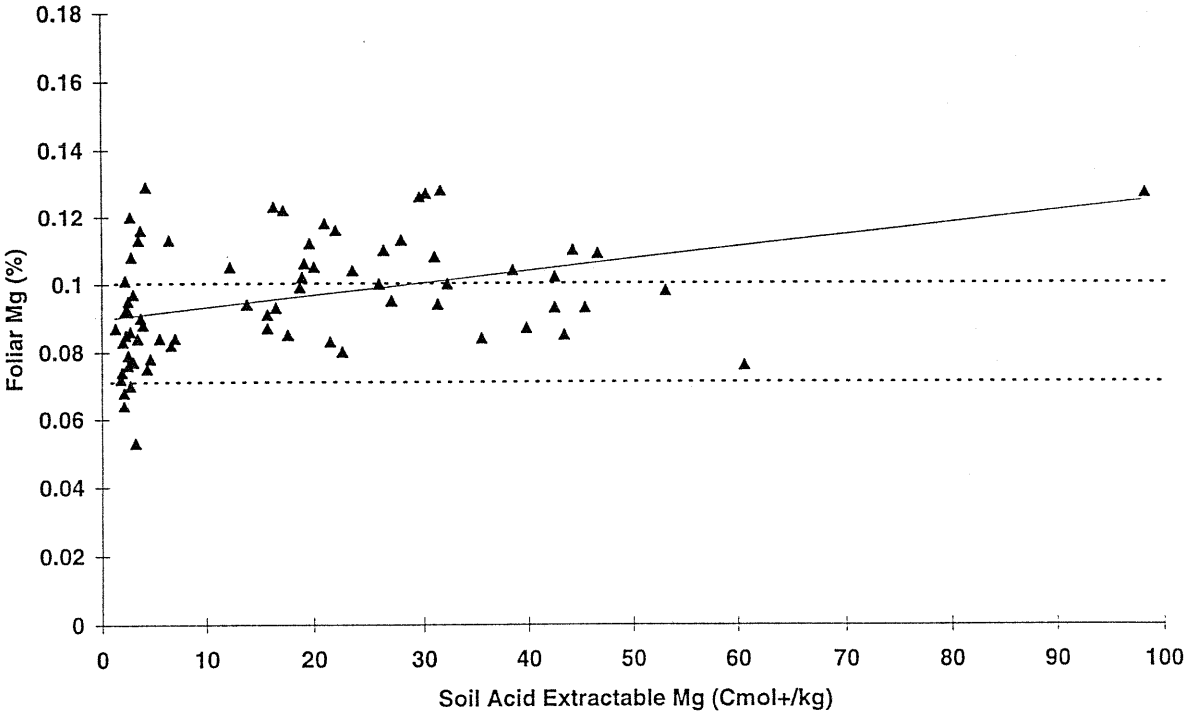
1 Year Foliar Mg Vs Soil Bray Mg



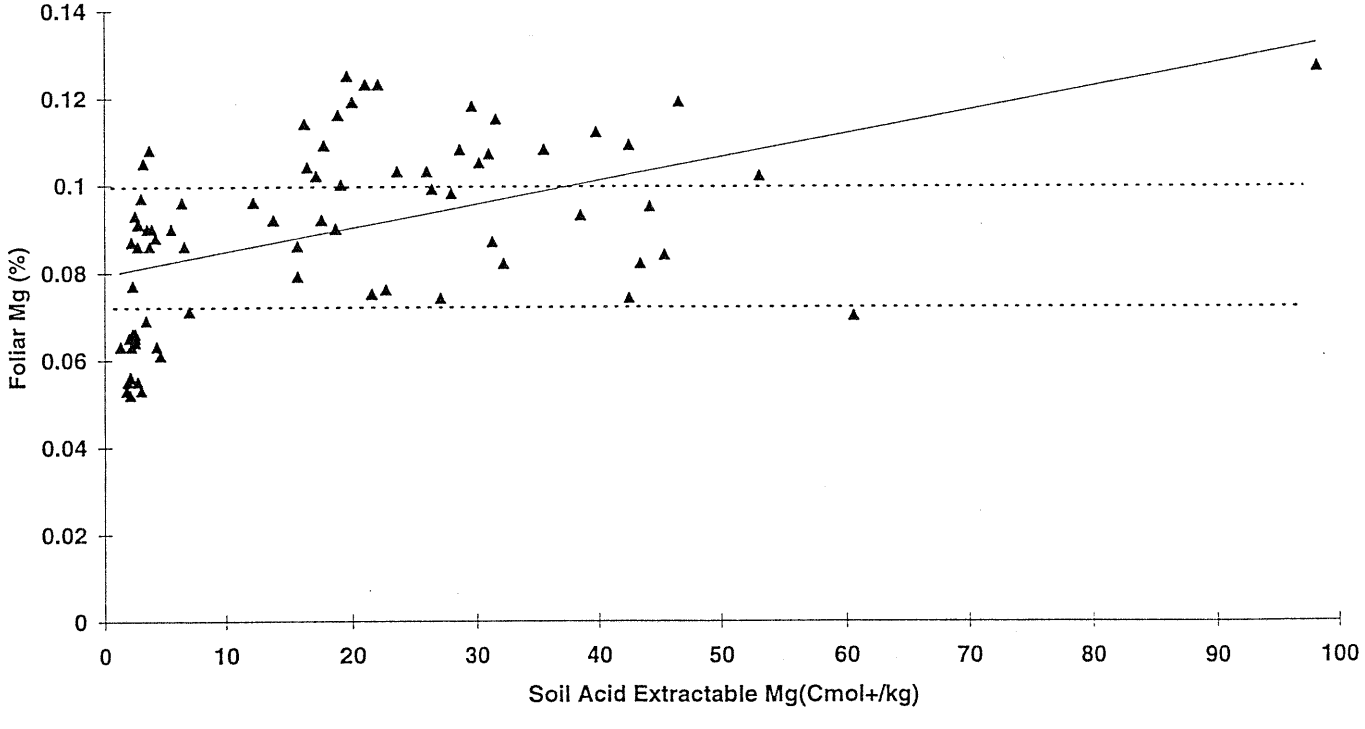
2 Year Foliar Mg Vs Soil Bray Mg



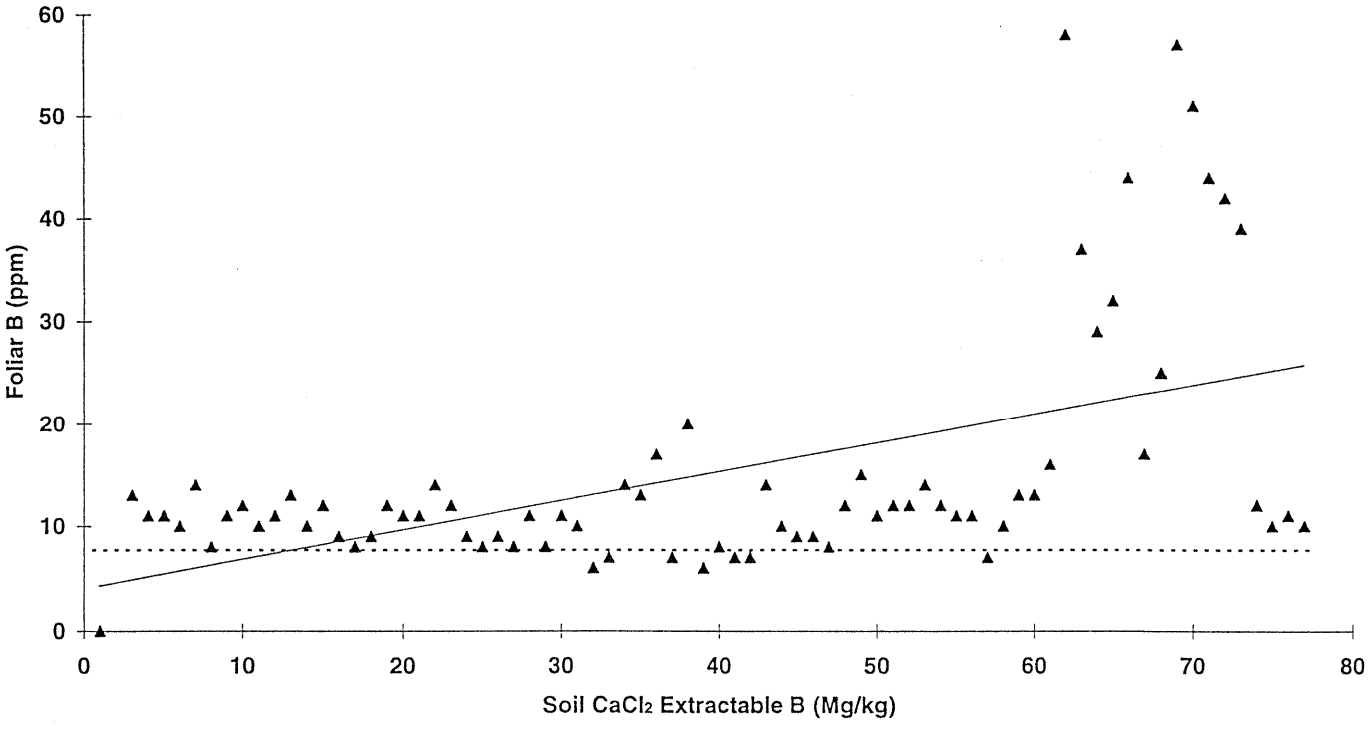
1 Year Foliar Mg Vs Soil Acid Extractable Mg



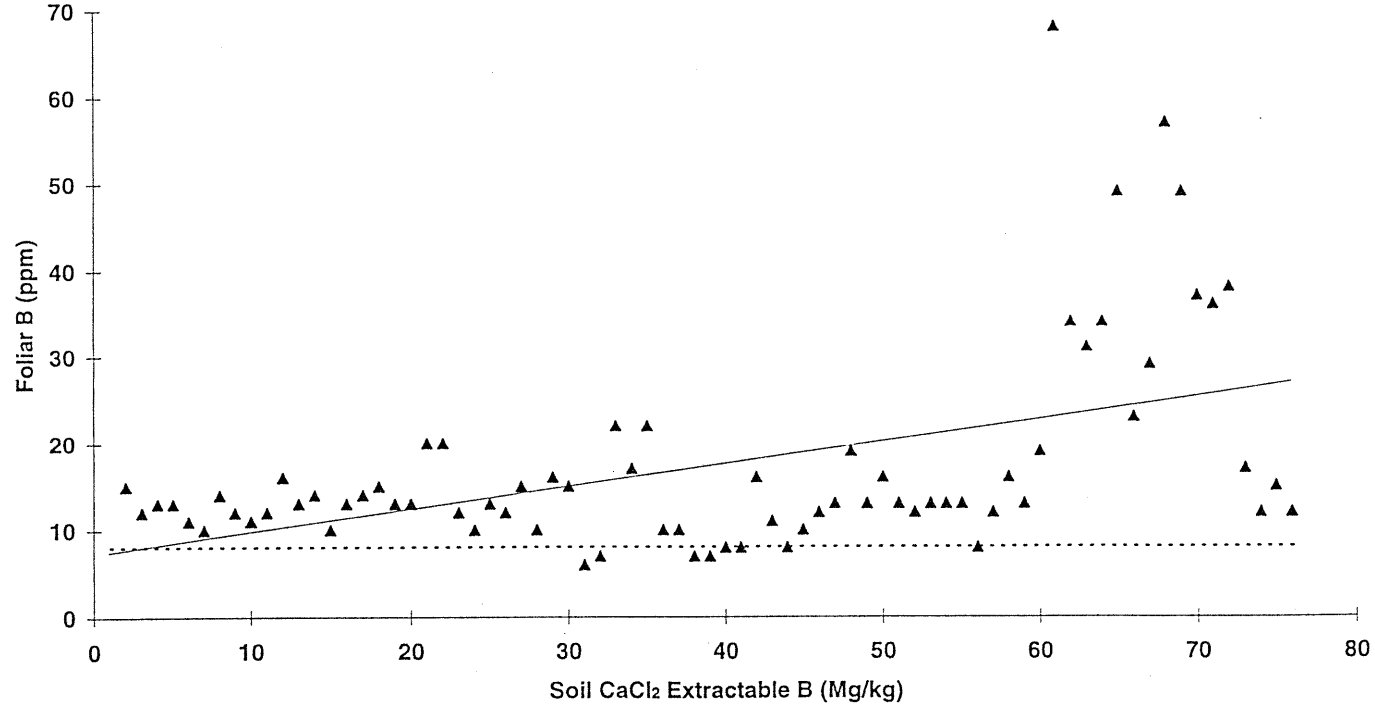
2 Year Foliar Mg Vs Soil Acid Extractable Mg

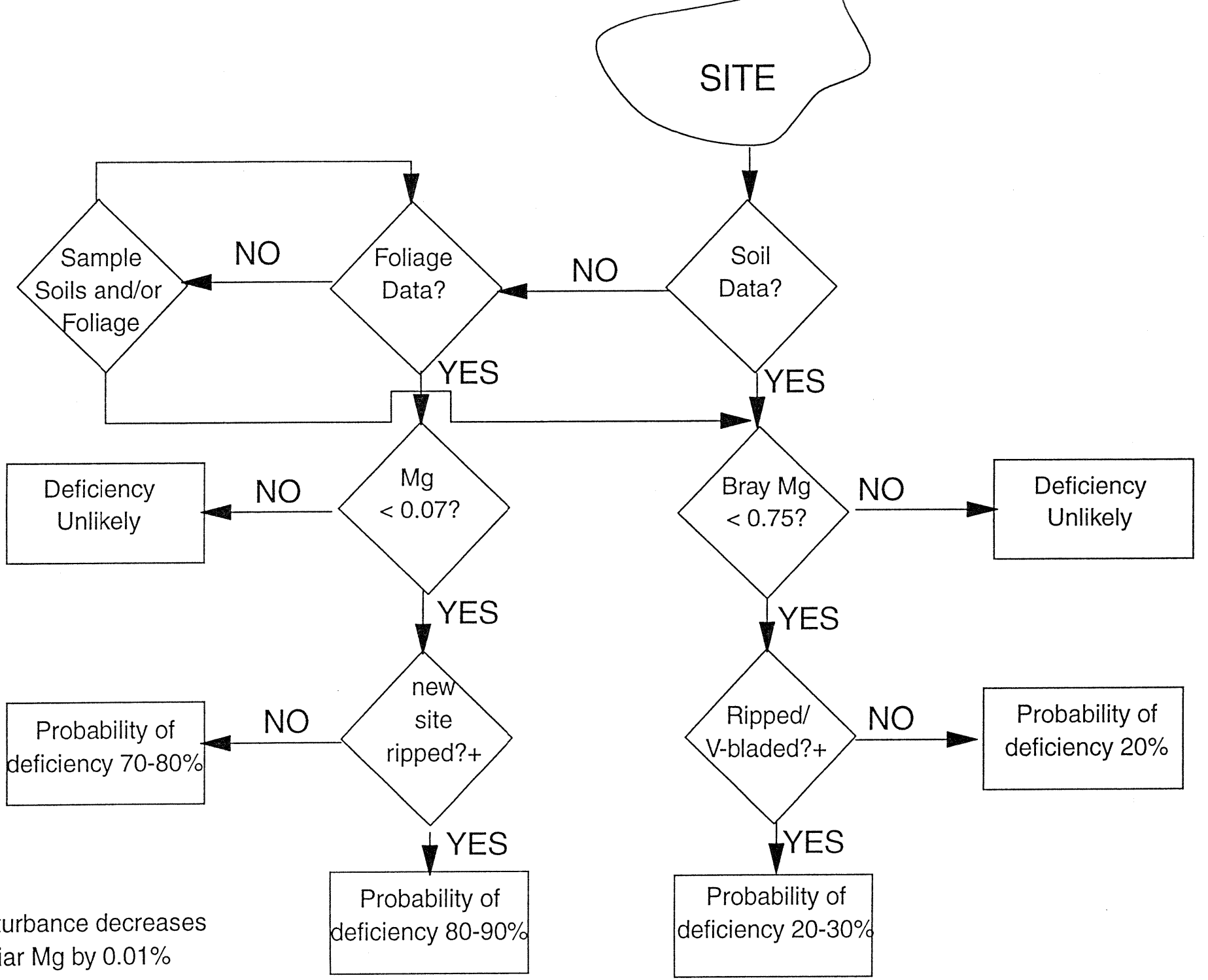


1 Year Foliar B Vs Soil $CaCl_2$ Extractable B



2 Year Foliar B Vs Soil $CaCl_2$ Extractable B




SITE
Soil Data?
NO
Foliage Data?
NO
Sample Soils and/or Foliage
YES
YES
Bray Mg < 0.75?
NO
Deficiency Unlikely
YES
Ripped/ V-bladed?+
NO
Probability of deficiency 20%
YES
Probability of deficiency 20-30%
Mg < 0.07?
NO
Deficiency Unlikely
YES
new site ripped?+
NO
Probability of deficiency 70-80%
YES
Probability of deficiency 80-90%
+ Disturbance decreases foliar Mg by 0.01%

CONCLUSIONS

- SOIL B TEST NOT FEASIBLE WITH THIS APPROACH
    - USE DROUGHT RISK, SOIL SERIES, SOIL TEXTURE, FOLIAR DATA

- BRAY MG CRITICAL LEVEL 0.8 MEQ/100G
- ACID MG CRITICAL LEVEL 9 MEQ/100G
- BELOW THESE, PROPORTION OF SITES <0.07% MG
- SITE DISTURBANCE DECREASES FOLIAR MG
- ROTATION EFFECT NSD IN THIS STUDY
- REGIONAL MODELS BETTER
- MULTI FACTOR SITE IDENTIFICATION PREFERRED
    - SOIL SERIES
    - SOIL TEST
    - FOLIAR DATA
    - MANAGEMENT HISTORY

SOIL TESTING FOR RESIDUAL P AVAILABILITY - TOWARDS AN INTEGRATED SOIL TEST

Historical

- development of Bray extract procedure
- refinement with sequential extractions

Current studies

- availability of the mineral P fraction (carry-over of applied fertiliser phosphates - super/triple/DAP)

  P adsorption studies to define *soil solution concentrations*

- changes in organic P fractions - radiata pine/mycorrhiza organic acid exudates (oxalate and citrate) as the "extractants"

  mineralisation of organic P

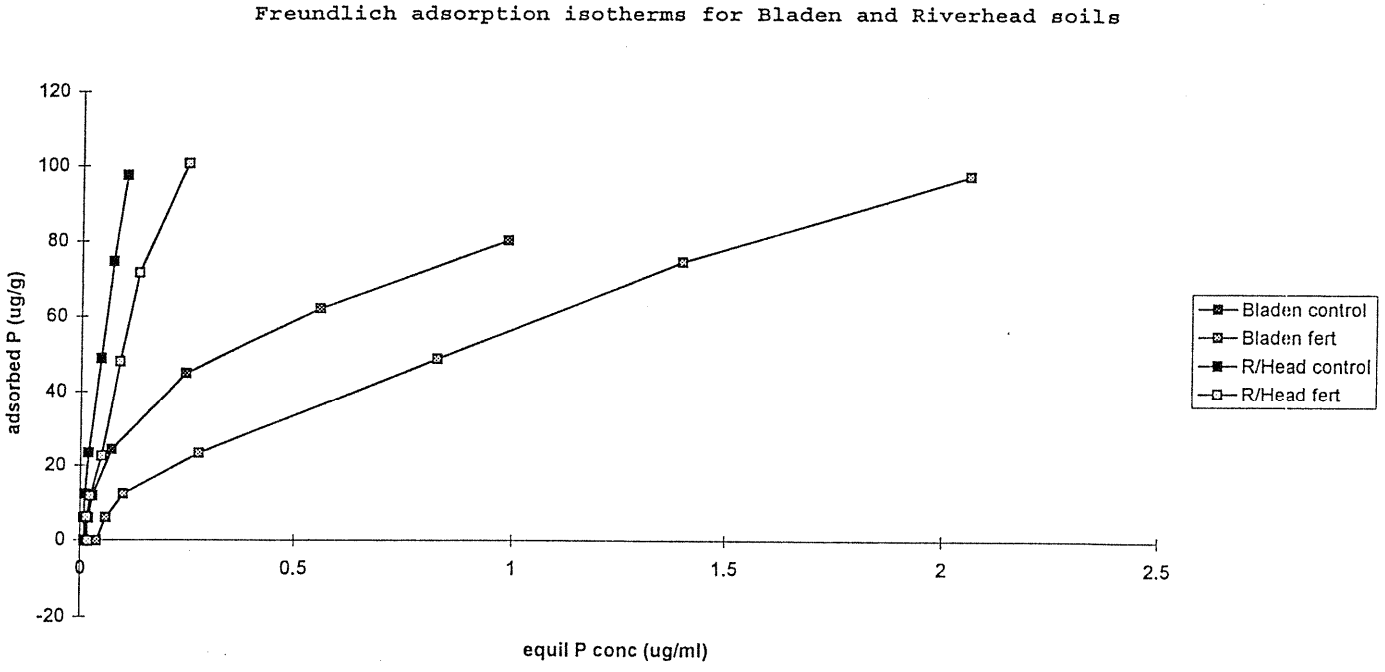
SOIL TESTING FOR RESIDUAL P AVAILABILITY - TOWARDS AN INTEGRATED SOIL TEST

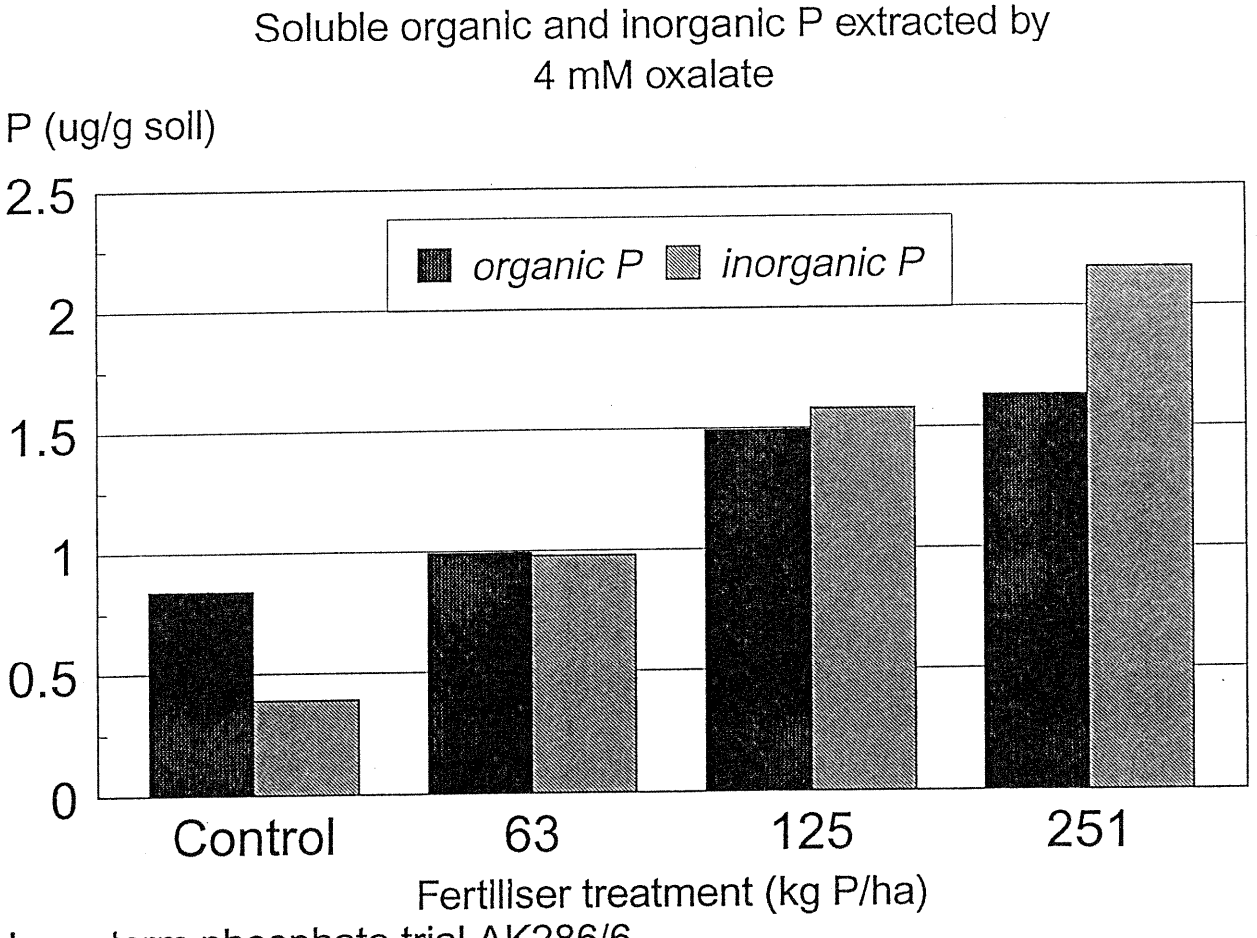
Continuing studies

P fertility = f (mineral P, organic P*)

* = concentration organic P - available for direct uptake by mycorrhizal roots

potential to mineralise to release inorganic P


Freundlich adsorption isotherms for Bladen and Riverhead soils
adsorbed P (ug/g)
120
100
80
60
40
20
0
-20
0
0.5
1
1.5
2
2.5
equil P conc (ug/ml)
Bladen control
Bladen fert
R/Head control
R/Head fert


Soluble organic and inorganic P extracted by
4 mM oxalate
P (ug/g soil)
2.5
2
1.5
1
0.5
0
organic P
inorganic P
Control
63
125
251
Fertiliser treatment (kg P/ha)
Long-term phosphate trial AK286/6

RECAP ON RECENT TRIAL REPORTS

COOP REPORT 76 - BORON
COOP REPORT 77 - N x P x SILIVICULTURE
COOP REPORT 78 - K RATES

MALCOLM SKINNER

The effect of boron fertilisers and weed control on the boron nutrition of young radiata pine. Age 6 results.

Treatments

Boron fertilisers

- Control
- Borax (soluble B)
- Colemanite (2-5 mm chip)
- Ulexite (2-5 mm chip)

Boron was applied at a rate of 6 kg B/ha.

Weed Control The effect of WC was assessed in factorial combination with fertilisers.

Trial Design Fertilisers (4) * Weed control (2) * replication (3) = 24 plots

Sites

- Central North Island (at Rerewaikaaitu Forest, Tasman Forestry Ltd)
- Nelson Region at Mariri (Harakeke) Forest

Both sites exhibit symptoms of B deficiency.

Weed control

Rerewaikaaitu: Galant (5l/ha) Versatile (1 l/ha) and Cropoil (2 l/ha)

Mariri: Velpar 20G at 5 kg active/ha.

The effect of fertilising, weed control and silviculture on the growth of radiata pine at Hunua Forest

Objective

To assess, from the perspective of forestry operations, the effect of thinning (and pruning), nutrient addition, and both in combination with weed control on subsequent growth of the crop.

The effect of fertilising, weed control and silviculture on the growth of radiata pine at Hunua Forest (continued)

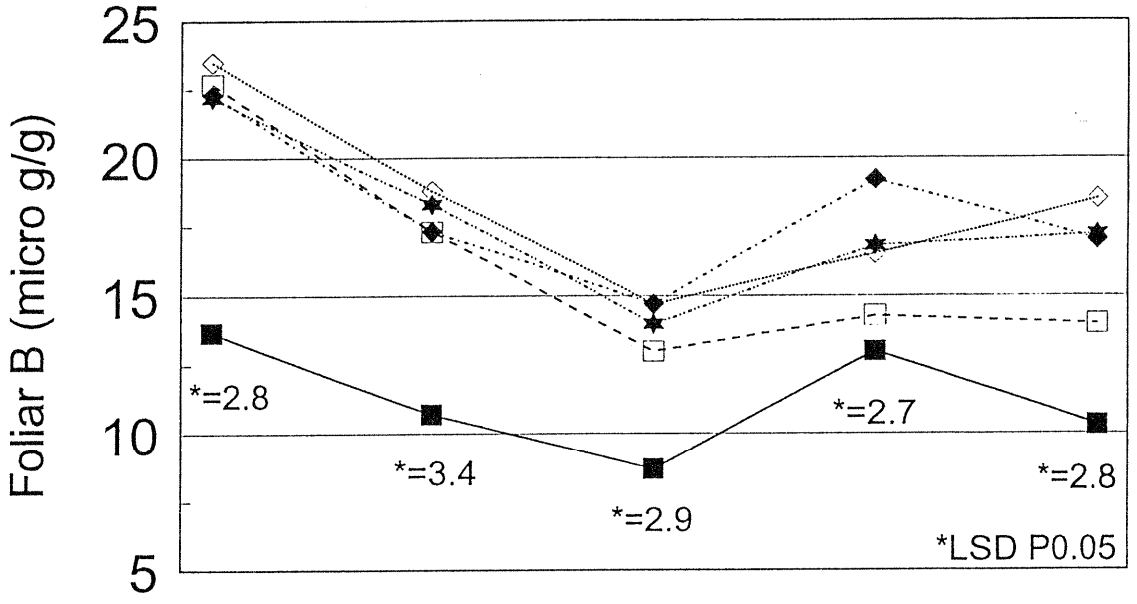
The site

- Hunua Forest Cpt 22/1 (Regional Forests Ltd)
- North aspectwith an average slope of 40°.
- Understorey vegetation consists mainly of shrubby hardwoods, gorse, pampas and ghania.
- The soil is moderately P deficient Te Rango clay loam/stony loam and has the following characteristics:

Depth (cm)	pH	total N %	Bray-P µg/g
0 - 10	5.1	0.258	5.3
10 - 20	5.1	0.155	2.8

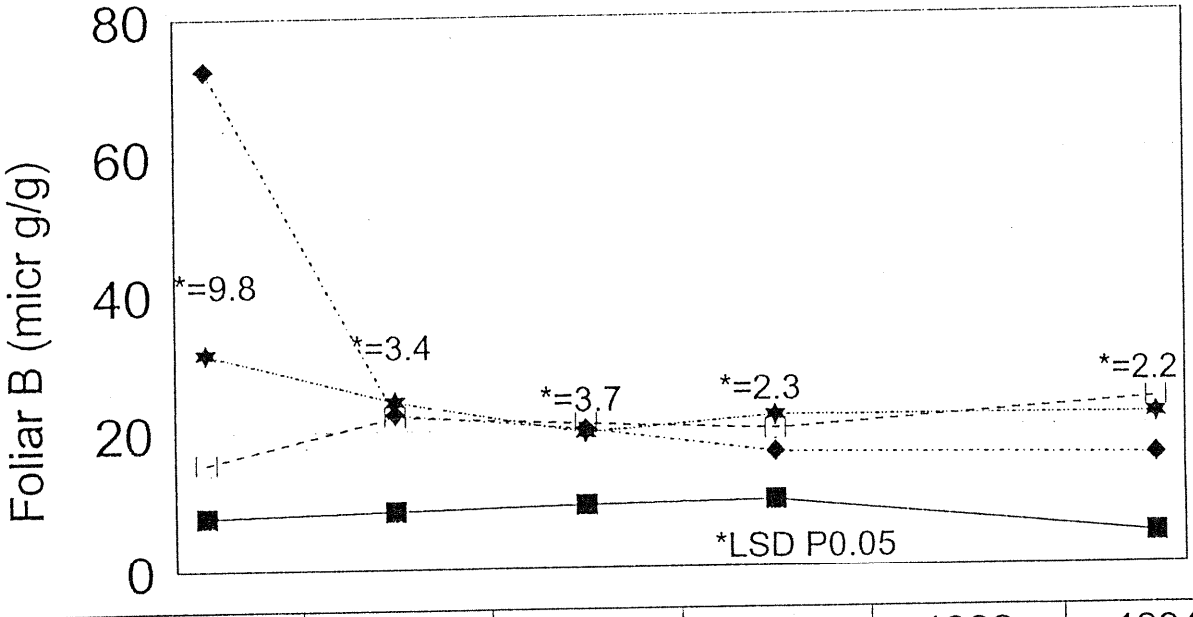
The site was planted with radiata pine in 1984 at a nominal stocking of 1665 sph..

Figure 1. The effect of boron source on foliar B concentrations at Mariri Forest



	1989	1990	1991	1992	1993
control	13.7	10.7	8.7	13.0	10.3
borax	22.3	17.3	14.7	19.2	17.0
ulexite	22.2	18.3	14.0	16.8	17.2
colemanite (Co)	22.7	17.3	13.0	14.3	14.0
colemanite (Fi)	23.5	18.8	14.7	16.5	18.5

Figure 2. The effect of boron source on foliar B concentrations at Rerewaikaaitu Forest



	1989	1990	1991	1992	1993	1994
control	7.8	8.5	9.2	9.7		4.5
borax	72.3	22.3	20.0	16.5		15.7
ulexite	31.3	24.2	19.5	21.7		21.5
colemanite	15.5	22.0	20.8	19.8		23.7

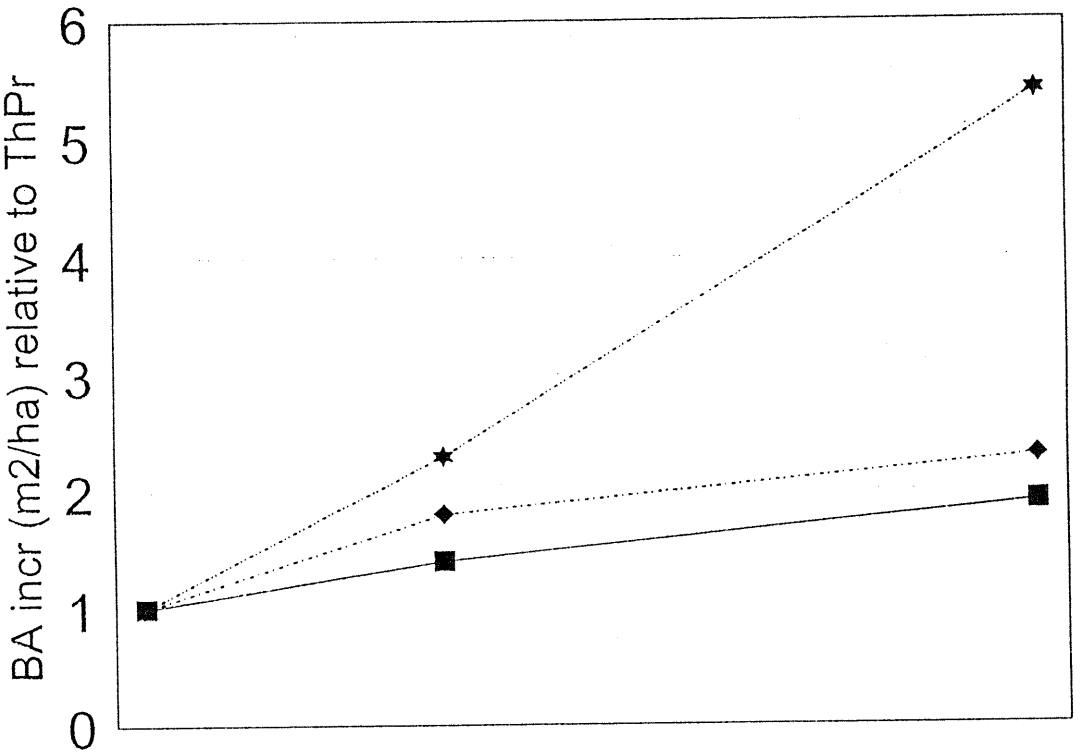
The effect of fertilising, weed control and silviculture on the growth of radiata pine at Hunua Forest (continued)

The treatments

The experiment was established in 1989, and the 5 treatments (in order of increasing input) were:

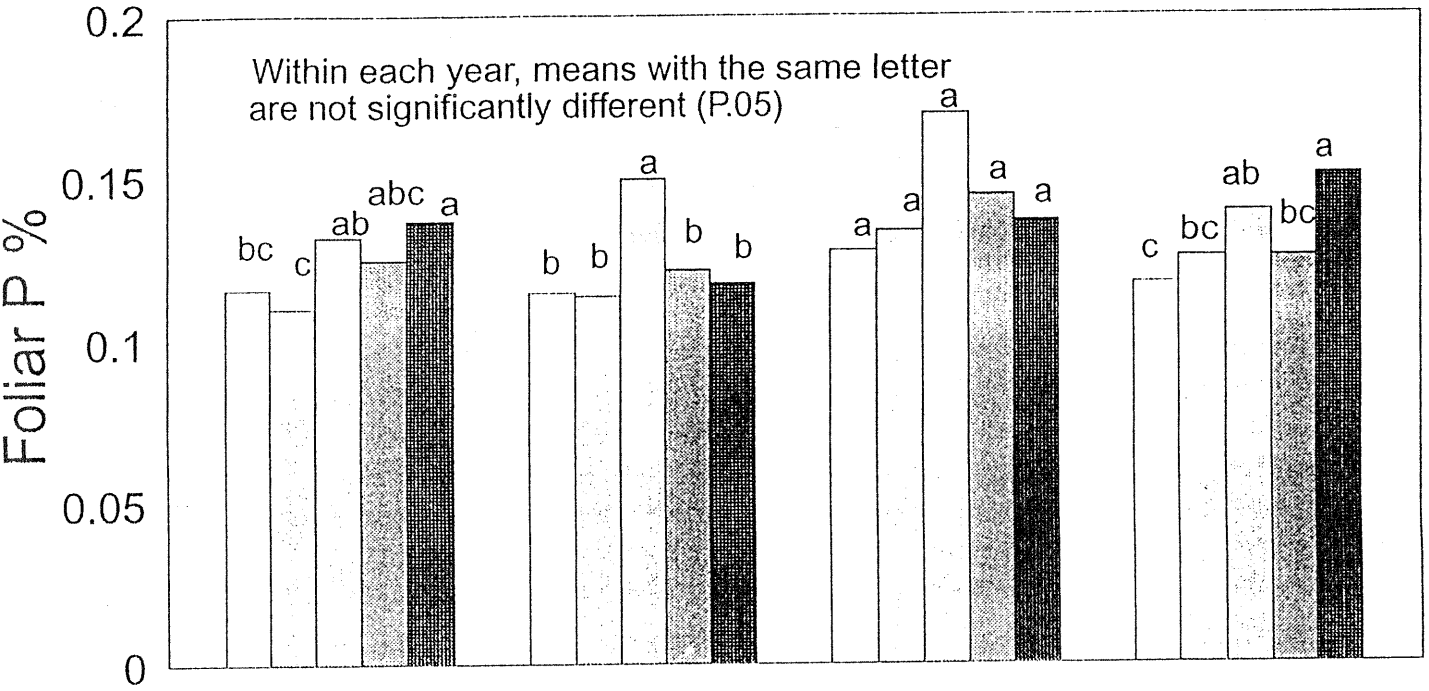
- Untended, at 1665 sph (varied between 1100 and 1800 between replicates)
- Thinned to waste (T) to 375 sph and pruned (Pr) to 2.5m
- T and Pr with phosphorus (P) added at 100 kg P/ha as Longlife Superphosphate
- T, Pr, P and nitrogen (N) added at 200 kg/ha as urea
- T, Pr, P, N with complete understorey vegetation control (cutting and follow up spraying with the herbicide "Roundup").

Fig. 2. The effect o fertiliser and weed control on BA (m2/ha) increase over the ThPr treatment



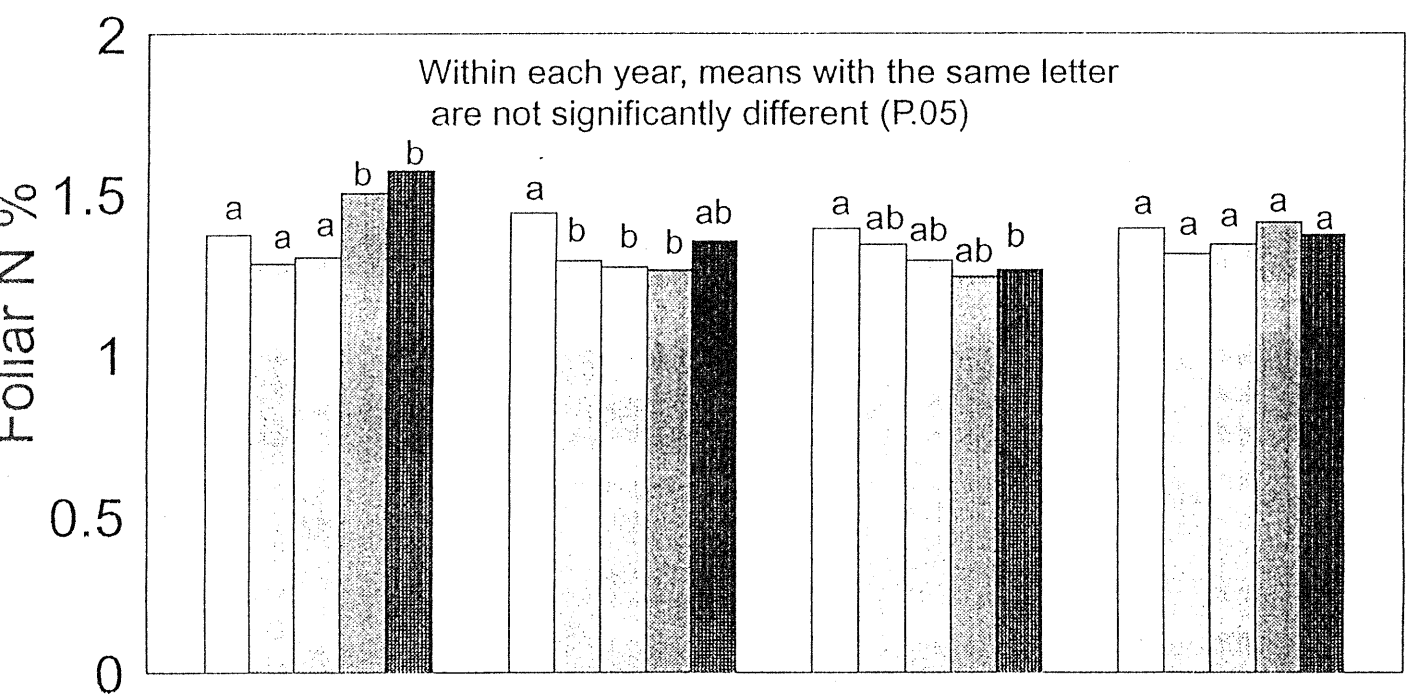
	1991	1992	1993	1994
ThPr.P ■	1.0	1.4		1.9
ThPr.PN ◆	1.0	1.8		2.3
ThPr.PN.Wc ★	1.0	2.3		5.4

Figure 3. The effect of treatment on foliar P response



	1990	1991	1992	1994
control	0.116	0.115	0.128	0.118
Th*Pr	0.110	0.114	0.134	0.126
Th*Pr*P	0.132	0.150	0.170	0.140
Th*Pr*PN	0.125	0.122	0.145	0.126
Th*Pr*PNW	0.137	0.118	0.137	0.151

Figure 4. The effect of treatment on foliar N response



	1990	1991	1992	1994
control	1.37	1.44	1.39	1.39
Th*Pr	1.28	1.29	1.34	1.31
Th*Pr*P	1.30	1.27	1.29	1.34
Th*Pr*PN	1.50	1.26	1.24	1.41
Th*Pr*PNW	1.57	1.35	1.26	1.37

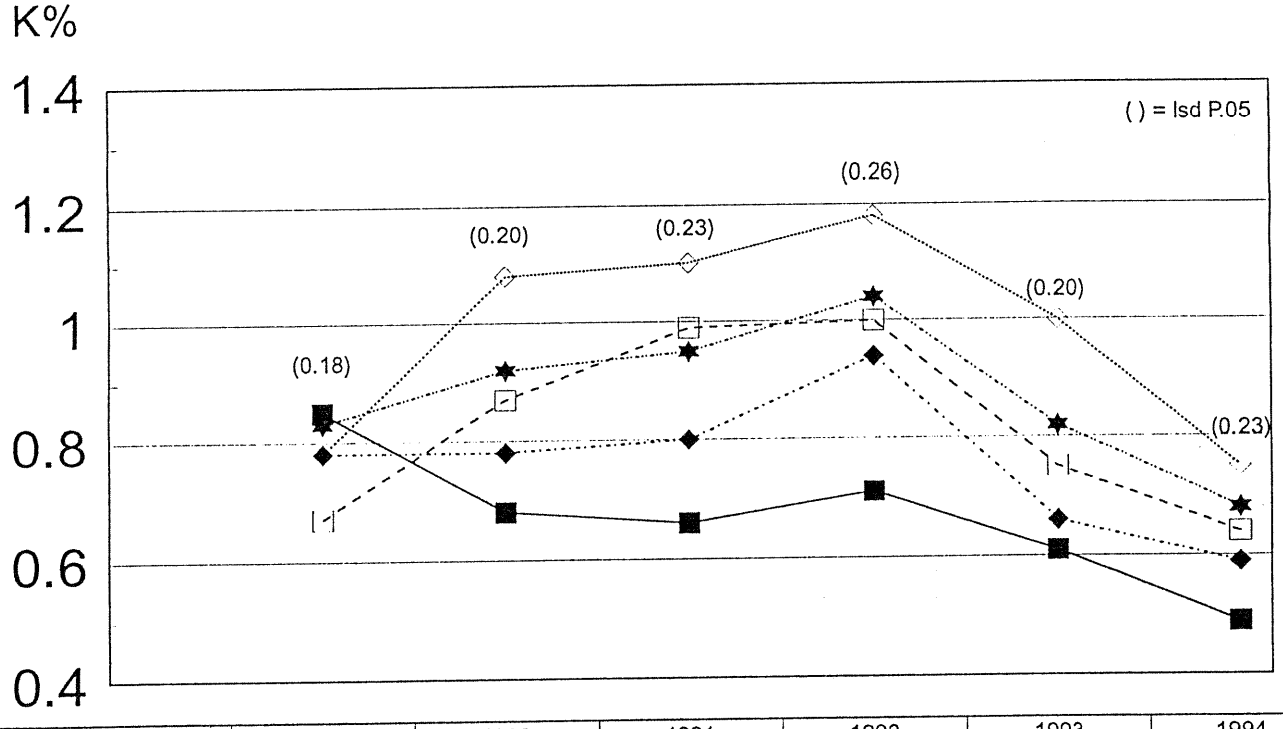
Conclusion

At a marginally P deficient site, thinning and pruning resulted in small improvements in the P nutrition of the crop. Additional fertiliser P (and N) further improved nutrition and growth, but the full potential of the crop (in relation to soil conditions) was realised only where competing weeds were controlled.

Site specific effects on K nutrition

Rotu

Figure 5b. Effect of K rates applied in spring 1989 on foliar K levels through to 1994 at Rotu



	1988	1989	1990	1991	1992	1993	1994
1K 0		0.85	0.68	0.66	0.71	0.61	0.49
6K 50		0.78	0.78	0.80	0.94	0.66	0.59
7K 100		0.83	0.92	0.95	1.04	0.82	0.68
8K 200		0.67	0.87	0.99	1.00	0.75	0.64
9K 400		0.78	1.08	1.10	1.18	1.00	0.75

The effect of rate and timing of potassium fertiliser on the growth and potassium nutrition of young radiata pine in Northland Results after six years.

Objective

The objective of this project was to quantify growth and nutritional responses to added K in young crops, on sites covering a range of foliar K concentrations where K alone was the only nutrient limiting growth.

The approach

The approach was to work with young radiata pine and to follow the decline in foliar K over consecutive years. Over a 3 year period, a number of rates of K were applied, and the response in foliar K was monitored by foliage sampling.

The sites

- Te Kopura sand at Cape Karikari, Haititaimarangi Block, courtesy of Northern Pulp Ltd (now Juken Nissho Ltd). The trees were 5 years old. Trial FR 68/1.

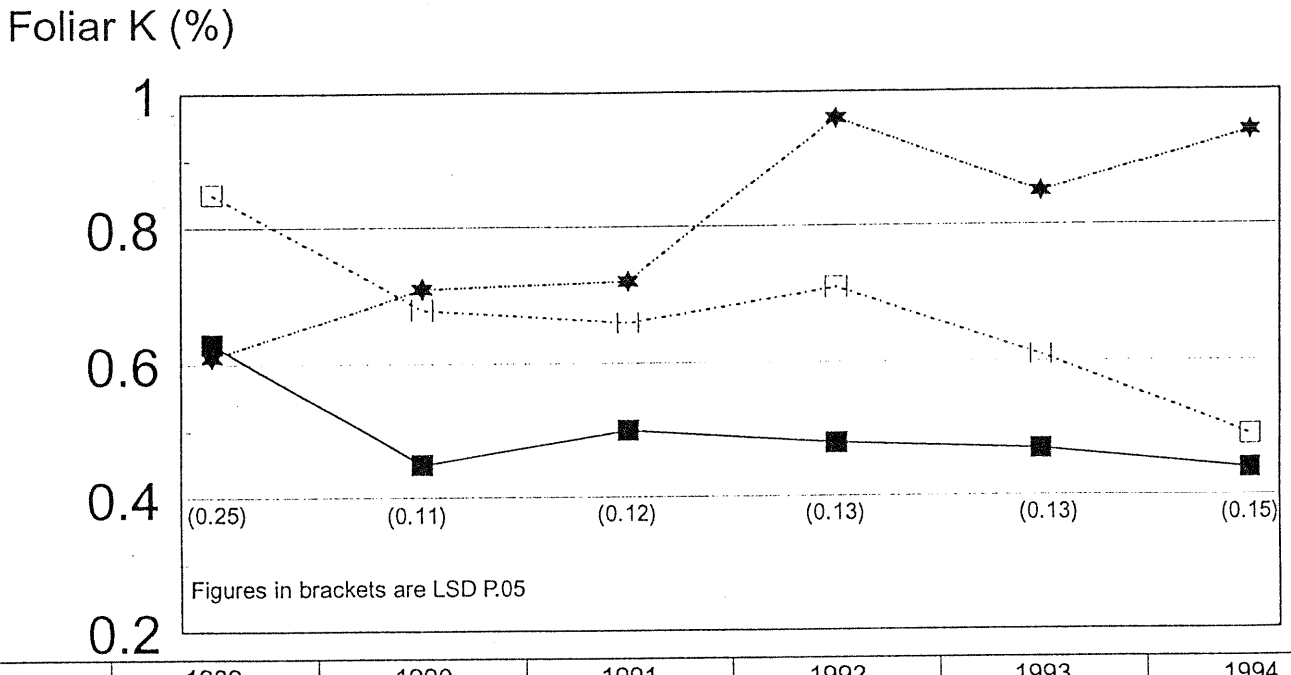
- Te Kopuru, after pasture, at Dargaville, Rotu Block, courtesy of New Zealand Forest Products, (now CHH Forests Ltd). The trees were 4 years old. Trial FR 68/2.

- Whakakohe loam at Pipiwai, Ngatihine Block, courtesy of Taitokerau Forests. The trees were 4 years old. Trial FR 68/3.

				DAP ADDED		
STAGE	**Trt No**	**K kg/ha**	**Timing**	**Haititaimarangii**	**Rotu**	**Pipiwai**
Stage 1	1	0	1988	yes	no	yes
	2	50	1988	yes	no	yes
	3	100	1988	yes	no	yes
	4	200	1988	yes	no	yes
	5	400	1988	yes	no	yes
Stage 2	6	50	1989	yes	no	yes
	7	100	1989	yes	no	yes
	8	200	1989	yes	no	yes
	9	400	1989	yes	no	yes
Stage 3	10	50	1990	yes	no	yes
	11	100	1990	yes	no	yes
	12	200	1990	yes	no	yes
	13	400	1990	yes	no	yes
Stage 1	14	0	1988	no	no	no
	15	100	1988	no	no	no

Changes in the K status of the control plots of radiata pine at the three sites (and the effect of the DAP base dressing)

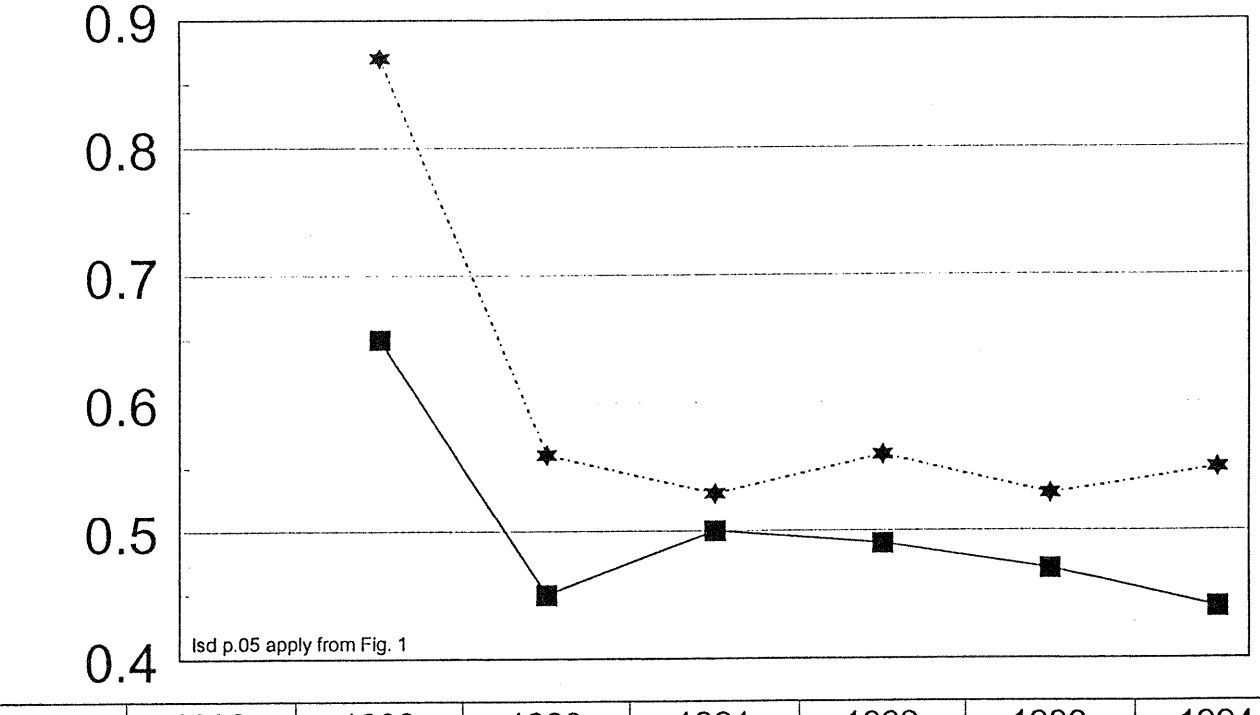
Figure 1. Changes in the controls (no K fertiliser) at the 3 sites



	1989	1990	1991	1992	1993	1994
Hait	0.63	0.45	0.50	0.48	0.47	0.44
Rotu	0.85	0.68	0.66	0.71	0.61	0.49
Pipiwai	0.61	0.71	0.72	0.96	0.85	0.94

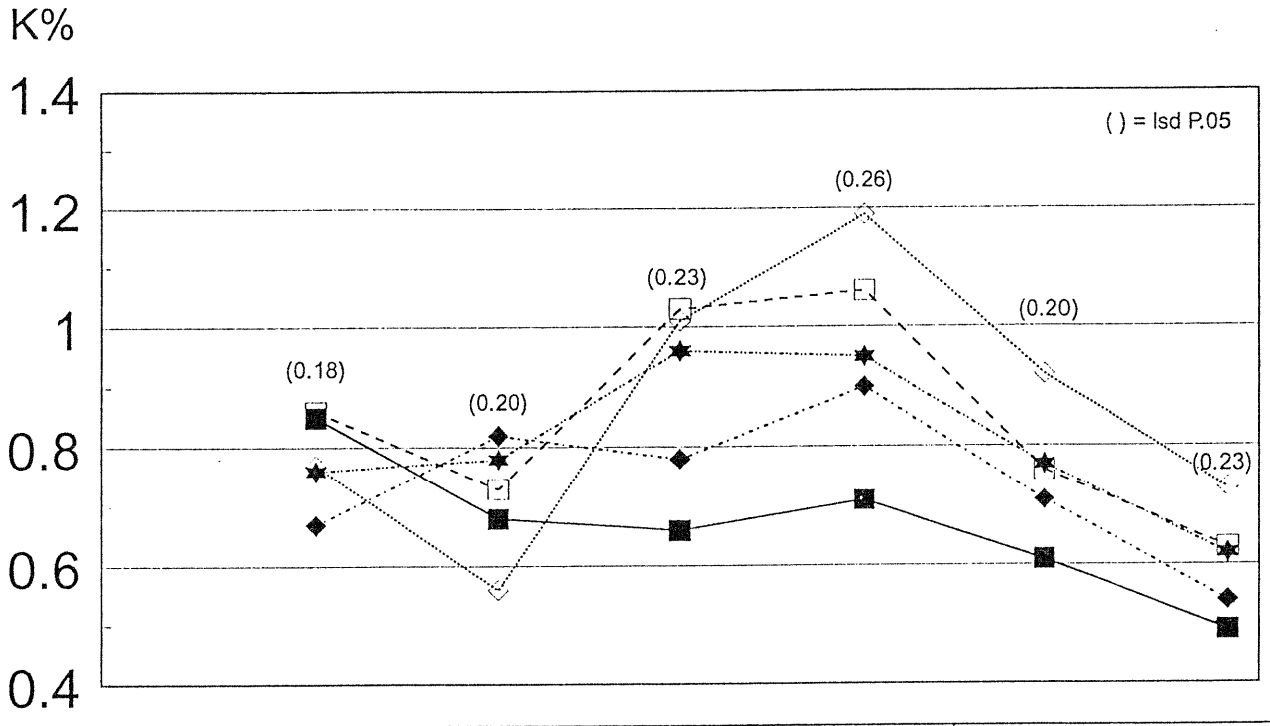
At Haititaimarangi and Pipiwai DAP was applied as a base treatment; at Rotu, DAP was not applied

Figure 1a. The effect of the DAP treatment on foliar K concentrations at Haititaimarangi



	1988	1989	1990	1991	1992	1993	1994
K 0, + NP		0.65	0.45	0.50	0.49	0.47	0.44
K 0, no NP		0.87	0.56	0.53	0.56	0.53	0.55

Figure 5c. Effect of K rates applied in spring 1990 on foliar K levels through to 1994 at Rotu



	1988	1989	1990	1991	1992	1993	1994
1 K 0		0.85	0.68	0.66	0.71	0.61	0.49
10 K 50		0.67	0.82	0.78	0.90	0.71	0.54
11 K 100		0.76	0.78	0.96	0.95	0.77	0.62
12 K 200		0.86	0.73	1.03	1.06	0.76	0.63
K400		0.77	0.56	1.01	1.19	0.92	0.73

Conclusions

- At all three sites foliar K concentrations remained above the probable critical level
- marked responses in the trees' foliar K nutrition to the rate and timing treatments; absence of significant growth response to K fertiliser at any of the rates of application.
- Lowest rate of 50 kg K/ha was, at all sites, insufficient to maintain elevated foliar K levels for an extended period.
- The 400 kg K/ha rate was super-optimal, and the 200 kg rate was similar in effectiveness.
- The 100 kg K/ha rate gave variable results.

It appears that for management, a rate somewhere in between 100 and 200 kg K/ha is required.

MAGNESIUM PASTURE AND PRUNING

TIM PAYN

MAGNESIUM*PASTURE*PRUNING

AIM: EFFECT OF MG, B AND GRASS ON TREE GROWTH AND NUTRIENT UPTAKE. EFFECT OF MG FERTILISER TYPE ON TREE GROWTH AND NUTRIENT UPTAKE.

- TRIAL INSTALLED 1989, INTENSIVELY STUDIED UNTIL 1991.
- FOLIAGE SAMPLED 1995 TO STUDY LONG TERM EFFECTS.

RESULTS:

MG*GRASS*BORON

- GRASS EFFECT ON FOLIAR NUTRIENTS GONE
- BORON CONCS STILL ABOVE CONTROL
- MG EFFECT ON FOLIAR MG CONCS STILL APPARENT
- MG DEPRESSED FOLIAR B AND CU

MG TYPES - EFFECT ON FOLIAR MG

- DIFFERENCE BETWEEN MGSO4 AND CONTROL DECREASING
- DIFFERENCE BETWEEN CALCINED MAGNESITE AND CONTROL INCREASING

CONCLUSIONS

- MGSO4 EFFECT SUPRISINGLY LONG LASTING
- CALCINED MAGNESITE EFFECT KICKING IN
- LEACHING LOSSES LESS WITH CALCINED MAGNESITE
- SOLUBLE BORON SOURCE @6KG/HA LASTS 5.5 YEARS AT LEAST
- GRASS COMPETITION EFFECTS DISAPPEAR WITH CANOPY CLOSURE
- MG SUPPRESSES B AND CU UPTAKE

RECOMMEND:
2 MORE FOLIAGE AND SOIL SAMPLING EXERCISES TO TRACK LONGEVITY OF FERTILISER EFFECT (1997 AND 1999). NO GROWTH MEASURES POSSIBLE.