Project Record No 1883

HOW ACCURATE IS A FOLIAGE RECOMMENDATION FOR BORON?

by

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FRI/INDUSTRY RESEARCH COOPERATIVES

EXECUTIVE SUMMARY

Seven collections of 15 individual trees were made from a range of sites in the Canterbury region to determine the confidence interval attached to a boron fertiliser recommendation. For a "grab sample" of approximately 5 trees it is 2 ppm while for a more thorough collection of 20 or more trees it is 1 ppm.

The seven sites were stratified by ridge, mid-slope and valley. The mean concentration of B in the pine foliage did not vary systematically with site. In fact one of the valley sites had the lowest mean concentration.

INTRODUCTION

In February and March 1988 several technical sessions of the National Forest Fertiliser Co-operative were held to try to raise the standards of foliage sampling to a uniformly high level. At those sessions the number of trees that needed to be sampled to achieve a certain confidence interval around each recommendation was discussed. Information was available for both Nitrogen and Phosphorus and after discussion it was decided that "25 in 25" was about the level to aim for - that is to say 25 trees per sample unit and no sample unit to exceed 25 hectares. However there was no information at all for boron. We just did not know whether the confidence interval around a similar size sample would be 1 or 5 ppm. It was decided at that time to do a collaborative study on a collection of sites in the Canterbury area and staff of Selwyn Plantation Board and Timberlands literally sprang into action.

METHODS

Seven collections of 15 individual trees were made from a range of sites in Ashley forest, Eyrewell forest and Selwyn Plantation Board forests as shown:-

Ashley Forest	flat site
Eyrewell forest	ridge
	midslope
	gully
Selwyn Plantation Board	ridge top
	midslope
	valley

The 15 trees were analysed separately for boron only.

Statistical analysis was used to calculate the within collection variability and that estimate of variability was then used to calculate the confidence interval around samples of varying size.

RESULTS

The individual tree analyses are given in Appendix 1. Figure 1 shows the standard deviation of the seven collections. It indicates that the variability increases with the mean but is stable at a standard deviation of 2 in the zone of main interest, that is to say a mean boron concentration of approximately 8 ppm. Table 1 shows the confidence interval that can be expected around samples of varying size with a mean concentration of 8 ppm.

The seven sites were stratified by ridge, mid-slope and valley because it was expected that they would differ one from another with ridges having the lowest concentrations, and valleys the greatest. However it did not work out that way. We had concluded previously that there was little benefit in stratifying by topography when sampling for P and N deficiency. It now seems that there is no strong evidence for such a stratification when sampling for B either.

Variability of boron foliage samples

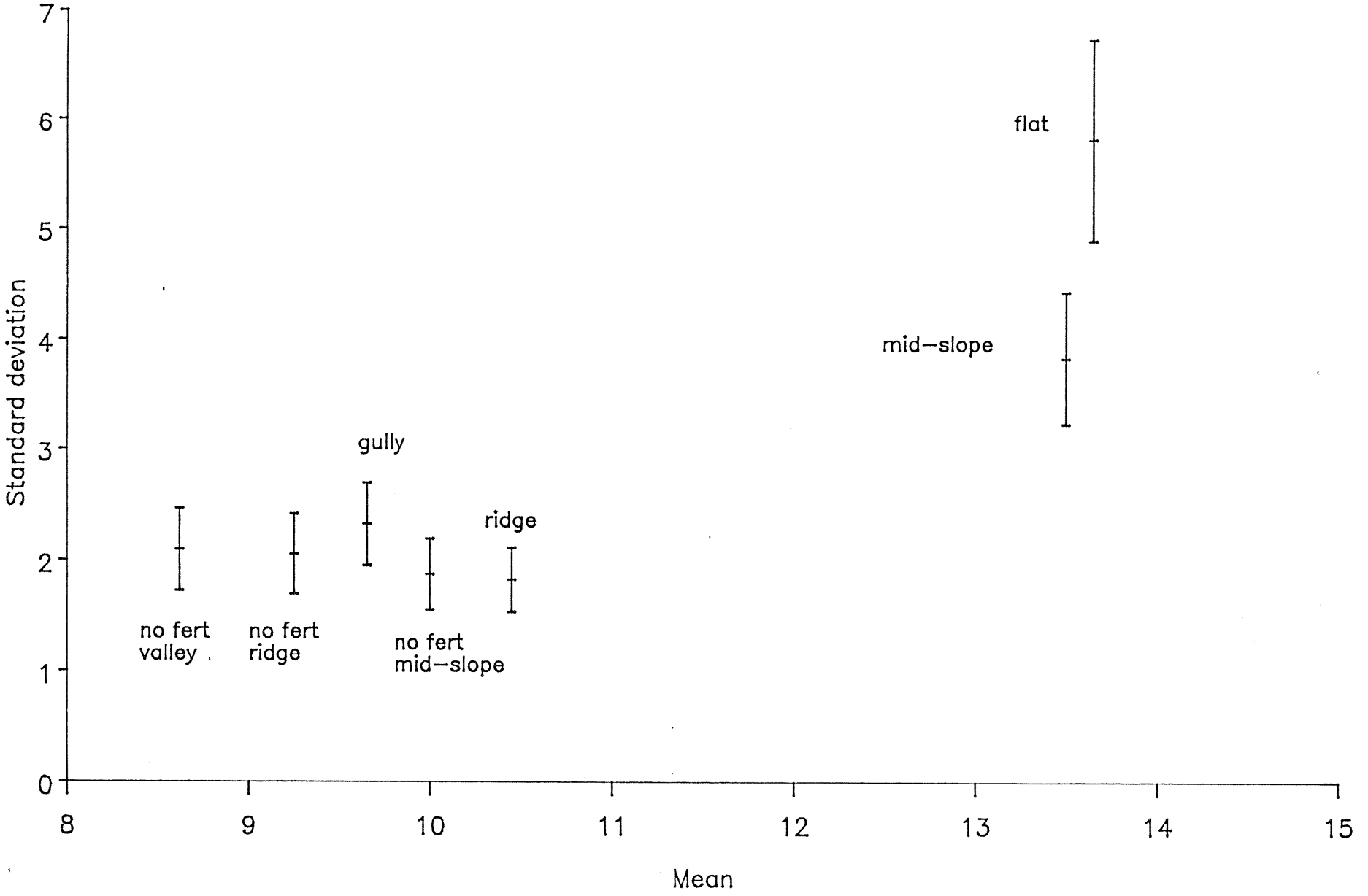

Table 1. Confidence intervals for foliar boron around an indicated average of 8 ppm.

If the sample size is:-	Then 19 times out of 20 the true mean will lie between:-	
5	6.1	& 9.9
10	6.7	9.3
15	6.9	9.1
20	7	9
30	7.3	8.7
50	7.4	8.6
100	7.6	8.4

CONCLUSIONS

Thus for a "grab sample" of a handful of trees the confidence interval is approximately 2 ppm while for a more thoroughly collected sample of more than 20 trees it is 1 ppm.

APPENDIX 1

BORON CONCENTRATIONS OF THE SAMPLE TREES

FOREST RESEARCH INSTITUTE
Soils and Site Amendment
LABORATORY REPORT
Experiment Foliage Analysis Results

Trial : CY0/0 Species : Radiata pine (P.RAD) Planted : 1986 Rotation : 0 Regime : MAIN

Forest : EYREWELL (EYWL) Cpt : 29 Date Collected : 3/88 Date Analysed : 5/88

Land Preparation : +

Log no.	Blk	Plt	Tre	Mat	Fertiliser history El.1	Yr	Cum.	El.2	Yr	Cum.	N	P	K	Ca	Mg	B	Fe	Mn	Zn	Cu	S	Al	Na	Cl
F15214				1YRFOL F	0000	00	0000	0000	00	0000						13								
				FLAT																				
F15215				1YRFOL F	0000	00	0000	0000	00	0000						25								
				FLAT																				
F15216				1YRFOL F	0000	00	0000	0000	00	0000						10								
				FLAT																				
F15217				1YRFOL F	0000	00	0000	0000	00	0000						10								
				FLAT																				
F15218				1YRFOL F	0000	00	0000	0000	00	0000						14								
				FLAT																				
F15219				1YRFOL F	0000	00	0000	0000	00	0000						14								
				FLAT																				
F15220				1YRFOL F	0000	00	0000	0000	00	0000						6								
				FLAT																				
F15221				1YRFOL F	0000	00	0000	0000	00	0000						16								
				FLAT																				
F15222				1YRFOL F	0000	00	0000	0000	00	0000						15								
				FLAT																				
F15223				1YRFOL F	0000	00	0000	0000	00	0000						8								
				FLAT																				
F15224				1YRFOL F	0000	00	0000	0000	00	0000						9								
				FLAT																				
F15225				1YRFOL F	0000	00	0000	0000	00	0000						31								
				FLAT																				
F15226				1YRFOL F	0000	00	0000	0000	00	0000						9								
				FLAT																				
F15227				1YRFOL F	0000	00	0000	0000	00	0000						14								
				FLAT																				
F15228				1YRFOL F	0000	00	0000	0000	00	0000						12								
				FLAT																				
F15229				1YRFOL F	0000	00	0000	0000	00	0000						11								
				FLAT																				
F15230				1YRFOL F	0000	00	0000	0000	00	0000						11								
				FLAT																				
F15231				1YRFOL F	0000	00	0000	0000	00	0000						15								
				FLAT																				
F15232				1YRFOL F	0000	00	0000	0000	00	0000						12								
				FLAT																				
F15233				1YRFOL F	0000	00	0000	0000	00	0000						18								
				FLAT																				

FOREST RESEARCH INSTITUTE
Soils and Site Amendment
LABORATORY REPORT
Experiment Foliage Analysis Results

Trial : CY0/0 Species : Radiata pine (P.RAD) Planted : 1986 Rotation : 0 Regime : INTEN

Forest : ASHLEY (ASHY) Cpt : 12 Date Collected : 3/88 Date Analysed : 4/88

Land Preparation : +

Log no.	Blk	Plt	Tre	Mat	Fertiliser history El.1	Yr	Cum.	El.2	Yr	Cum.	N	P	K	Ca	Mg	B	Fe	Mn	Zn	Cu	S	Al	Na	Cl
F15154				1YRFOL RIDGE	F 0000	00	0000	0000	00	0000						11								
F15155				1YRFOL RIDGE	F 0000	00	0000	0000	00	0000						11								
F15156				1YRFOL RIDGE	F 0000	00	0000	0000	00	0000						14								
F15157				1YRFOL RIDGE	F 0000	00	0000	0000	00	0000						10								
F15158				1YRFOL RIDGE	F 0000	00	0000	0000	00	0000						12								
F15159				1YRFOL RIDGE	F 0000	00	0000	0000	00	0000						9								
F15160				1YRFOL RIDGE	F 0000	00	0000	0000	00	0000						10								
F15161				1YRFOL RIDGE	F 0000	00	0000	0000	00	0000						10								
F15162				1YRFOL RIDGE	F 0000	00	0000	0000	00	0000						8								
F15163				1YRFOL RIDGE	F 0000	00	0000	0000	00	0000						12								
F15164				1YRFOL RIDGE	F 0000	00	0000	0000	00	0000						14								
F15165				1YRFOL RIDGE	F 0000	00	0000	0000	00	0000						8								
F15166				1YRFOL RIDGE	F 0000	00	0000	0000	00	0000						8								
F15167				1YRFOL RIDGE	F 0000	00	0000	0000	00	0000						9								
F15168				1YRFOL RIDGE	F 0000	00	0000	0000	00	0000						12								
F15169				1YRFOL RIDGE	F 0000	00	0000	0000	00	0000						9								
F15170				1YRFOL RIDGE	F 0000	00	0000	0000	00	0000						10								
F15171				1YRFOL RIDGE	F 0000	00	0000	0000	00	0000						9								
F15172				1YRFOL RIDGE	F 0000	00	0000	0000	00	0000						12								
F15173				1YRFOL RIDGE	F 0000	00	0000	0000	00	0000						11								
F15174				1YRFOL MID SLOPE	F 0000	00	0000	0000	00	0000						8								
F15175				1YRFOL MID SLOPE	F 0000	00	0000	0000	00	0000						12								

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Trial : CY0/0 Species : Radiata pine (P.RAD) Planted : 1986 Rotation : 0 Regime : INTEN

Forest : ASHLEY (ASHY) Cpt : 12 Date Collected : 3/88 Date Analysed : 4/88

Land Preparation : +

Log no.	Blk	Plt	Tre	Mat	Fertiliser history						N	P	K	Ca	Mg	B	Fe	Mn	Zn	Cu	S	Al	Na	Cl
					El.1	Yr	Cum.	El.2	Yr	Cum.														
F15176				1YRFOL MID SLOPE	F	0000	00 0000	0000	00	0000						8								
F15177				1YRFOL MID SLOPE	F	0000	00 0000	0000	00	0000						11								
F15178				1YRFOL MID SLOPE	F	0000	00 0000	0000	00	0000						13								
F15179				1YRFOL MID SLOPE	F	0000	00 0000	0000	00	0000						24								
F15180				1YRFOL MID SLOPE	F	0000	00 0000	0000	00	0000						15								
F15181				1YRFOL MID SLOPE	F	0000	00 0000	0000	00	0000						17								
F15182				1YRFOL MID SLOPE	F	0000	00 0000	0000	00	0000						16								
F15183				1YRFOL MID SLOPE	F	0000	00 0000	0000	00	0000						15								
F15184				1YRFOL MID SLOPE	F	0000	00 0000	0000	00	0000						13								
F15185				1YRFOL MID SLOPE	F	0000	00 0000	0000	00	0000						9								
F15186				1YRFOL MID SLOPE	F	0000	00 0000	0000	00	0000						10								
F15187				1YRFOL MID SLOPE	F	0000	00 0000	0000	00	0000						13								
F15188				1YRFOL MID SLOPE	F	0000	00 0000	0000	00	0000						15								
F15189				1YRFOL MID SLOPE	F	0000	00 0000	0000	00	0000						11								
F15190				1YRFOL MID SLOPE	F	0000	00 0000	0000	00	0000						15								
F15191				1YRFOL MID SLOPE	F	0000	00 0000	0000	00	0000						13								
F15192				1YRFOL MID SLOPE	F	0000	00 0000	0000	00	0000						19								
F15193				1YRFOL MID SLOPE	F	0000	00 0000	0000	00	0000						13								
F15194				1YRFOL GULLY	F	0000	00 0000	0000	00	0000						11								
F15195				1YRFOL GULLY	F	0000	00 0000	0000	00	0000						10								
F15196				1YRFOL GULLY	F	0000	00 0000	0000	00	0000						8								
F15197				1YRFOL GULLY	F	0000	00 0000	0000	00	0000						10								

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Experiment Foliage Analysis Results

Trial : CY0/0 Species : Radiata pine (P.RAD) Planted : 1986 Rotation : 0 Regime : INTEN

Forest : ASHLEY (ASHY) Cpt : 12 Date Collected : 3/88 Date Analysed : 4/88

Land Preparation : +

Log no.	Blk	Plt	Tre	Mat	Fertiliser history El.1	Yr	Cum.	El.2	Yr	Cum.	N	P	K	Ca	Mg	B	Fe	Mn	Zn	Cu	S	Al	Na	Cl
F15198				1YRFOL GULLY	F 0000	00	0000	0000	00	0000						8								
F15199				1YRFOL GULLY	F 0000	00	0000	0000	00	0000						12								
F15200				1YRFOL GULLY	F 0000	00	0000	0000	00	0000						8								
F15201				1YRFOL GULLY	F 0000	00	0000	0000	00	0000						9								
F15202				1YRFOL GULLY	F 0000	00	0000	0000	00	0000						8								
F15203				1YRFOL GULLY	F 0000	00	0000	0000	00	0000						9								
F15204				1YRFOL GULLY	F 0000	00	0000	0000	00	0000						8								
F15205				1YRFOL GULLY	F 0000	00	0000	0000	00	0000						8								
F15206				1YRFOL GULLY	F 0000	00	0000	0000	00	0000						7								
F15207				1YRFOL GULLY	F 0000	00	0000	0000	00	0000						12								
F15208				1YRFOL GULLY	F 0000	00	0000	0000	00	0000						8								
F15209				1YRFOL GULLY	F 0000	00	0000	0000	00	0000						8								
F15210				1YRFOL GULLY	F 0000	00	0000	0000	00	0000						8								
F15211				1YRFOL GULLY	F 0000	00	0000	0000	00	0000						16								
F15212				1YRFOL GULLY	F 0000	00	0000	0000	00	0000						13								
F15213				1YRFOL GULLY	F 0000	00	0000	0000	00	0000						12								

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Experiment Foliage Analysis Results

Trial : CY0/0 Species : Radiata pine (P.RAD) Planted : 1986 Rotation : 1 Regime : FRAME

Forest : No forest name (PRIV) Cpt : 0 Date Collected : 2/88 Date Analysed : 4/88

Land Preparation : SPRY +

Log no.	Blk	Plt	Tre	Mat	Fertiliser history El.1	Yr	Cum.	El.2	Yr	Cum.	N	P	K	Ca	Mg	B	Fe	Mn	Zn	Cu	S	Al	Na	Cl
F14470			1	1YRFOL F	0000	00	0000	0000	00	0000						6								
			NO	FERT RIDGE TOP																				
F14471			2	1YRFOL F	0000	00	0000	0000	00	0000						9								
			NO	FERT RIDGE TOP																				
F14472			3	1YRFOL F	0000	00	0000	0000	00	0000						9								
			NO	FERT RIDGE TOP																				
F14473			4	1YRFOL F	0000	00	0000	0000	00	0000						7								
			NO	FERT RIDGE TOP																				
F14474			5	1YRFOL F	0000	00	0000	0000	00	0000						9								
			NO	FERT RIDGE TOP																				
F14475			6	1YRFOL F	0000	00	0000	0000	00	0000						13								
			NO	FERT RIDGE TOP																				
F14476			7	1YRFOL F	0000	00	0000	0000	00	0000						10								
			NO	FERT RIDGE TOP																				
F14477			8	1YRFOL F	0000	00	0000	0000	00	0000						10								
			NO	FERT RIDGE TOP																				
F14478			9	1YRFOL F	0000	00	0000	0000	00	0000						7								
			NO	FERT RIDGE TOP																				
F14479			10	1YRFOL F	0000	00	0000	0000	00	0000						8								
			NO	FERT RIDGE TOP																				
F14480			11	1YRFOL F	0000	00	0000	0000	00	0000						14								
			NO	FERT RIDGE TOP																				
F14481			12	1YRFOL F	0000	00	0000	0000	00	0000						10								
			NO	FERT RIDGE TOP																				
F14482			13	1YRFOL F	0000	00	0000	0000	00	0000						9								
			NO	FERT RIDGE TOP																				
F14483			14	1YRFOL F	0000	00	0000	0000	00	0000						10								
			NO	FERT RIDGE TOP																				
F14484			15	1YRFOL F	0000	00	0000	0000	00	0000						8								
			NO	FERT RIDGE TOP																				
F14485			16	1YRFOL F	0000	00	0000	0000	00	0000						9								
			NO	FERT RIDGE TOP																				
F14486			1	1YRFOL F	0000	00	0000	0000	00	0000						11								
			NO	FERT MID SLOPE																				
F14487			2	1YRFOL F	0000	00	0000	0000	00	0000						9								
			NO	FERT MID SLOPE																				
F14488			3	1YRFOL F	0000	00	0000	0000	00	0000						15								
			NO	FERT MID SLOPE																				
F14489			4	1YRFOL F	0000	00	0000	0000	00	0000						8								
			NO	FERT MID SLOPE																				
F14490			5	1YRFOL F	0000	00	0000	0000	00	0000						12								
			NO	FERT MID SLOPE																				
F14491			6	1YRFOL F	0000	00	0000	0000	00	0000						9								
			NO	FERT MID SLOPE																				

FOREST RESEARCH INSTITUTE
Soils and Site Amendment
LABORATORY REPORT
Experiment Foliage Analysis Results

Trial : CY0/0 Species : Radiata pine (P.RAD) Planted : 1986 Rotation : 1 Regime : FRAME

Forest : No forest name (PRIV) Cpt : 0 Date Collected : 2/88 Date Analysed : 4/88

Land Preparation : SPRY +

Log no.	Blk	Plt	Tre	Mat	Fertiliser history El.1	Yr	Cum.	El.2	Yr	Cum.	N	P	K	Ca	Mg	B	Fe	Mn	Zn	Cu	S	Al	Na	Cl
F14492			7	1YRFOL F	0000	00	0000	0000	00	0000						10								
			NO	FERT MID SLOPE																				
F14493			8	1YRFOL F	0000	00	0000	0000	00	0000						9								
			NO	FERT MID SLOPE																				
F14494			9	1YRFOL F	0000	00	0000	0000	00	0000						9								
			NO	FERT MID SLOPE																				
F14495			10	1YRFOL F	0000	00	0000	0000	00	0000						8								
			NO	FERT MID SLOPE																				
F14496			11	1YRFOL F	0000	00	0000	0000	00	0000						11								
			NO	FERT MID SLOPE																				
F14497			12	1YRFOL F	0000	00	0000	0000	00	0000						7								
			NO	FERT MID SLOPE																				
F14498			13	1YRFOL F	0000	00	0000	0000	00	0000						9								
			NO	FERT MID SLOPE																				
F14499			14	1YRFOL F	0000	00	0000	0000	00	0000						10								
			NO	FERT MID SLOPE																				
F14500			15	1YRFOL F	0000	00	0000	0000	00	0000						11								
			NO	FERT MID SLOPE																				
F14501			16	1YRFOL F	0000	00	0000	0000	00	0000						11								
			NO	FERT MID SLOPE																				
F14502			17	1YRFOL F	0000	00	0000	0000	00	0000						11								
			NO	FERT MID SLOPE																				
F14503			1	1YRFOL F	0000	00	0000	0000	00	0000						13								
			NO	FERT VALLEY																				
F14504			2	1YRFOL F	0000	00	0000	0000	00	0000						11								
			NO	FERT VALLEY																				
F14505			3	1YRFOL F	0000	00	0000	0000	00	0000						9								
			NO	FERT VALLEY																				
F14506			4	1YRFOL F	0000	00	0000	0000	00	0000						8								
			NO	FERT VALLEY																				
F14507			5	1YRFOL F	0000	00	0000	0000	00	0000						7								
			NO	FERT VALLEY																				
F14508			6	1YRFOL F	0000	00	0000	0000	00	0000						7								
			NO	FERT VALLEY																				
F14509			7	1YRFOL F	0000	00	0000	0000	00	0000						7								
			NO	FERT VALLEY																				
F14510			8	1YRFOL F	0000	00	0000	0000	00	0000						6								
			NO	FERT VALLEY																				
F14511			9	1YRFOL F	0000	00	0000	0000	00	0000						7								
			NO	FERT VALLEY																				
F14512			10	1YRFOL F	0000	00	0000	0000	00	0000						12								
			NO	FERT VALLEY																				
F14513			11	1YRFOL F	0000	00	0000	0000	00	0000						8								
			NO	FERT VALLEY																				

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Experiment Foliage Analysis Results

Trial : CY0/0 Species : Radiata pine (P.RAD) Planted : 1986 Rotation : 1 Regime : FRAME

Forest : No forest name (PRIV) Cpt : 0 Date Collected : 2/88 Date Analysed : 4/88

Land Preparation : SPRY +

Log no.	Blk	Plt	Tre	Mat	Fertiliser history El.1	Yr	Cum.	El.2	Yr	Cum.	N	P	K	Ca	Mg	B	Fe	Mn	Zn	Cu	S	Al	Na	Cl
F14514			12	1YRFOL F NO FERT VALLEY	0000	00	0000	0000	00	0000						11								
F14515			13	1YRFOL F NO FERT VALLEY	0000	00	0000	0000	00	0000						9								
F14516			14	1YRFOL F NO FERT VALLEY	0000	00	0000	0000	00	0000						9								
F14517			15	1YRFOL F NO FERT VALLEY	0000	00	0000	0000	00	0000						7								
F14518			16	1YRFOL F NO FERT VALLEY	0000	00	0000	0000	00	0000						7								