Performance And Tree Health Of A Six Year Old Planted Kauri Stand In The Bay Of Plenty

G.A. Steward
Forest Research
Rotorua
and
Ian Barton
Chairman, Tane's Tree Trust
Hunua

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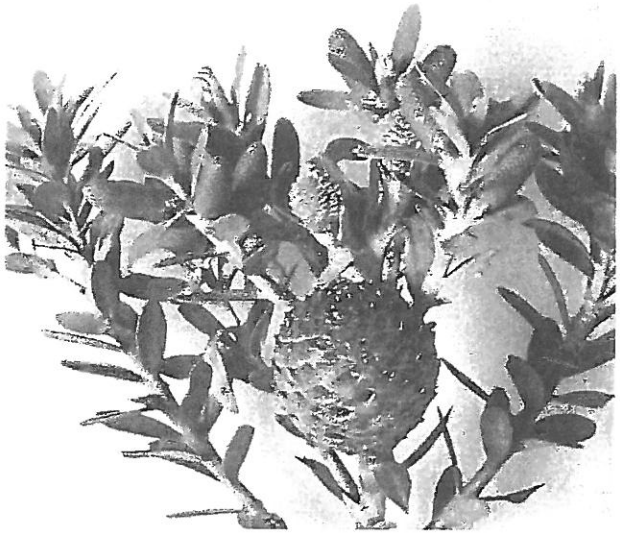


Abstract

Kauri (*Agathis australis*) planted in the Bay of Plenty between 1994-1997 was assessed in April 2003 for height and diameter growth. Two 0.064 hectare Permanent Sample Plots were established and eighty trees were measured. The mean height was 5.7 m; mean diameter was 10.2 cm. Elite trees were identified that had a mean height of 6.7 m and diameter of 12.8 cm. Three categories of tree health were identified and foliage samples collected for nutritional analyses. No element tested indicated either nutrient deficiency or toxicity. The performance of this stand since planting dramatically exceeds that measured on all other sites.

Background

The property, owned by Mr and Mrs Sutton, was planted with several hundred kauri, as a forestry option, on what had been a kiwi-fruit orchard.

The first planting was in autumn 1994. However, these initial seedlings were either too small, had poor root systems or were "end-of-line" stock (runts). Many died. The major planting was ≈ 200 trees in the spring of 1997. Although the ages alternate by row it is, in 2003, hard to identify the difference based on size.

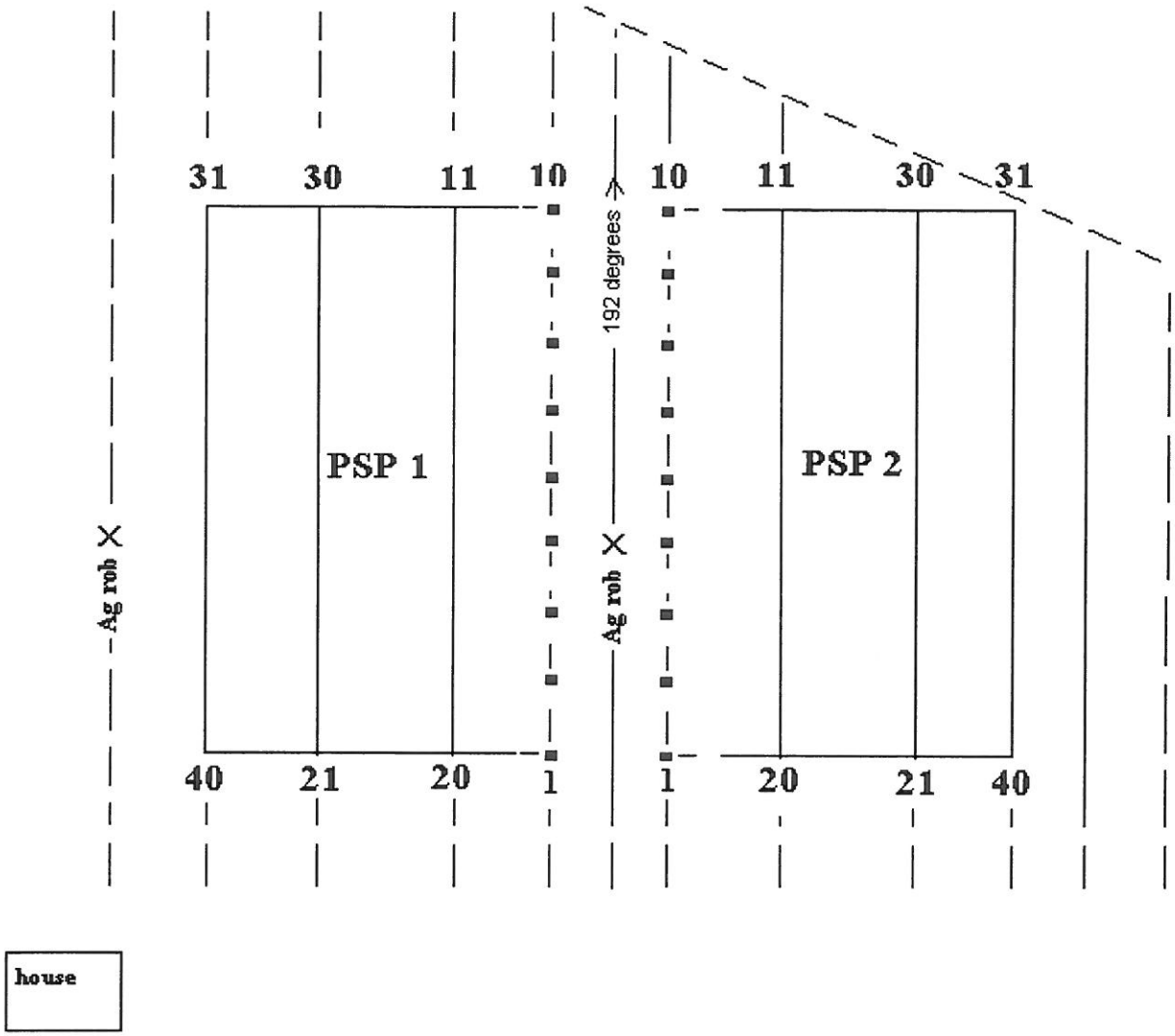
Site Description

The site, located in Te Puna, is less than 20 m above sea level and is well protected by shelterbelts (ca. 9 - 12 metres tall) on the south and south-west sides, but is more open to the north. The kauri were planted in a grid pattern (4 x 4 m spacing - 625 stems per hectare) with the old kiwi-fruit poles being used as "stakes" for toppled or at risk trees. The height at planting, except for the small trees in 1994, was about one metre.

The soil properties are described (by the owner) as a light grey sandy loam of variable depth over a heavy clay. Soil Bureau Bulletin No 5 lists the soil as Katikati black sandy loam derived from Waihi Ash consisting of 20 - 36 cm of black sandy loam on 13 cm moderately free brown sandy loam on yellow brown compact sandy loam. Natural fertility is medium, pH 6.2 - 6.4.

Two 0.064 ha rectangular Permanent Sample Plots were established within the stand. The plots are parallel to each other and contain 40 trees/plot (4 rows x 10 trees/row) (Fig 1).

Figure 1. Location of PSP's within planted kauri stand



Results

Height and Diameter

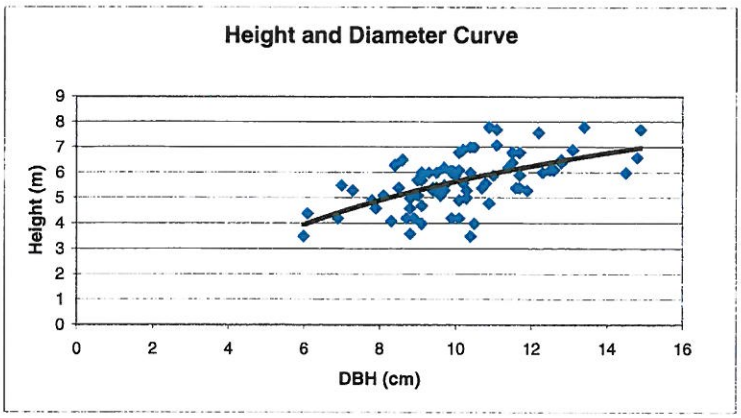
Eighty trees, assumed to be the 1997 planting group, i.e. at age 6, in two equal sized plots were assessed for height, and diameter at breast height (DBH). Little difference in either DBH or height was recorded between the two PSP's. Mean height for all trees was 5.7 m (0.95 m/annum) and for DBH was 10.2 cm (1.7cm/annum) (Table 1). A height/diameter curve shows a moderate correlation (Fig 2).

Table 1. Performance of planted kauri at age 6.

	Mean Height (m)	Mean Diameter (cm)	Incidence multi-leadering[1]	Incidence long-internode[2]	Mean Foliage Cover[3]
PSP 1	5.6	10.1	17.5%	15%	2.05
PSP 2	5.7	10.2	25.0%	12.5%	1.95
Total	5.7	10.2	21.3%	13.75%	2.0

[1] two or more leaders
[2] long-internode = >1.0m between branch whorls
[3] visual foliage cover classes. 1= light cover; 2= medium cover; 3= heavy cover

Figure 2. Height and diameter curve for both PSP's combined



Elite Trees

Within the two Sample Plots 7.5% of the stems were identified as 'elite' trees based on superior performance and form. The mean DBH and height of 'elite' trees within this stand are 12.8 cm (2.1 cm/annum) and 6.7 m (1.1 m/annum) respectively. Elite trees also have a marginally higher foliage cover value (2.3) than non-elite's (1.9). The elite

stems will be followed over the years to determine whether that performance will be maintained over time.

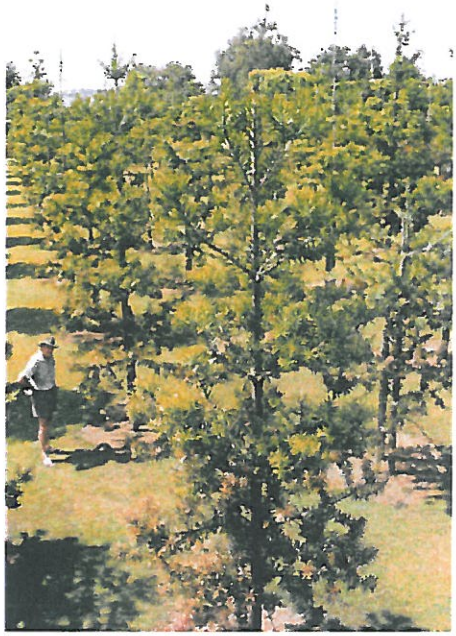


Figure 3. Six year old planted kauri

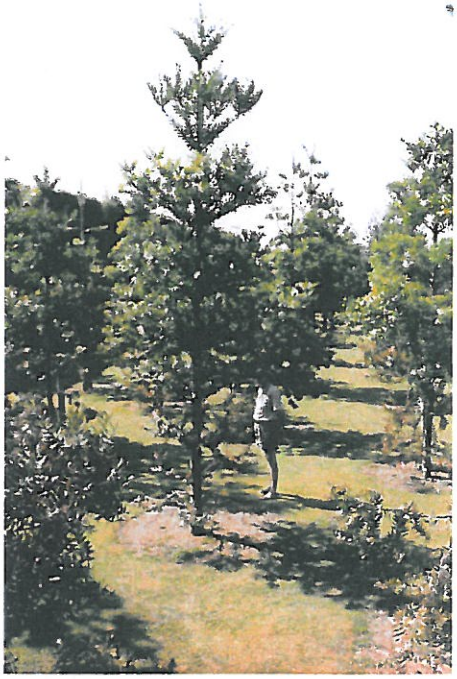


Figure 4. Elite tree with owner Maurice Sutton

Foliage Sampling

The performance of this planting and the history of the site suggested a high level of nutrients available for kauri. A number of trees (<5%) had recently died or were currently showing yellowed/deformed foliage and other signs of toxic chemical/nutrient levels (Figure 5). A number of foliage variations based on foliage colour and health were identified and samples were collected for nutrient analysis (Table 2).

Table 2. Type and number of foliage samples collected for nutrient analysis.

Foliage type	No stems sampled
Green (healthy)	15
Red (healthy)	6
Yellow (unhealthy, deformed)	4

Figure 5. Yellow and deformed foliage on unhealthy kauri

Ca levels were described as very good although a query was raised about the very large difference with the yellowed tissue. Mg shows the same trend with increasing Mg in the coloured foliage. Zn levels may be marginal, in comparison with radiata (Table 3).

Table 3. Element levels from foliage nutrient analysis.

Foliage type	Al (ppm)	B (ppm)	C (%)	Ca (%)	Cu (ppm)	Fe (ppm)	K (%)
Green	37	18	55.17	0.294	3	26	0.978
Red	34	21	54.69	0.525	2	23	0.880
Yellow	37	15	52.34	1.035	2	15	1.283

Foliage type	Mg (%)	Mn (ppm)	N (%)	Na (%)	P (%)	Zn (ppm)
Green	0.079	47	1.23	0.010	0.103	10
Red	0.102	120	1.26	0.009	0.094	10
Yellow	0.217	38	1.21	0.018	0.086	11

Discussion

Growth appears to occur throughout the season. Normally there are two, sometimes 3, bursts in height growth each year. Diameter growth is probably continuous. Height growth is often so fast that leaders become floppy and have to be tied. Tying involves splinting tops with bamboo stakes, which are left until the stem hardens. A three-wheeled cherry picker with a 12 foot reach is used for all upper tree operations. However some trees are now getting out of reach and may suffer if they can't be splinted. Tree tops are also broken by strong winds and many trees have pollarded. The owner reduces multiple shoots, through pruning, to the best one.

The trees are watered whenever the owner thinks the site is getting too dry - probably after about two weeks without rain during summer months. A drum on the tractor is used, which can be quickly filled and has a large hose for watering. Each tree is given about 2 gallons (9.08L).

The owner has registered the planting with the Western Bays District Council, stating that the trees are being grown for timber. This area is designated Rural H in the District Plan.

Some kauri already carry female cones, both the 2003 crop and 2004. One tree had over 200 cones. Male catkins have also been seen, with remnants from previous years on the ground. It is unknown whether viable seed is being produced.

The variation of individual tree response to this very pampered treatment is quite wide. There are some which have maintained very good form and are already quite large. These trees have not usually required any form of silvicultural treatment and are usually wind-firm earlier than others. Other trees are of the elongated variety and still others have not put on much height growth despite the treatment - however they still have very dense foliage (and this is general for most trees except the elongated ones). It is suspected that the reason that these trees are growing so fast is that their individual leaf areas are so high. (The owner estimates that the total leaf area will have doubled over the last 12 months).

Some trees have died - even when they were reasonably large and looked healthy. Mr Sutton describes them as having bled to death and there was much gum evident on the trunks. It is suspected that this is a symptom of Phytophthora and would be worth investigating.

There are various forms of growth. Quite common is the bolting (long internode) leader with no branches (Figure 6). Leaders can be up to 5m long without branches. Other trees have good conventional form although branches on the upper stem are getting a little large. There is considerable variation in foliage colour. Both red (ranging from brown to red) and green (again a range of greens) foliaged trees are present and there are some that are almost bright yellow. (Note that since kiwi-fruit removal the area has had no fertiliser; except for N on the trees with yellow foliage.) Application of urea had no effect. The yellowing and mortality of some kauri was initially assumed to be due to an excessive level of an element, although later proven to be not the source of the problem.

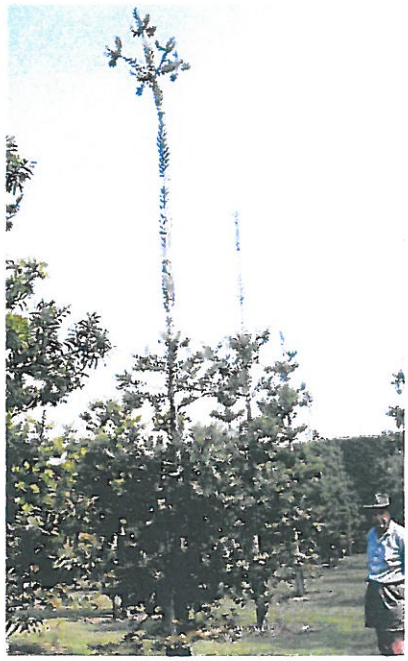


Figure 6. Example of long internode

It is also known that old (treated) poles and kiwi-fruit frames were burnt in another part of the orchard (Cu, Cr, As) and is possibly an alternative cause of death of some kauri here.

Another possibility for the mortality and yellowing of some individuals could be to do with the origin of the seed that this stand was produced from. If the seed was collected from a restricted source where inbreeding becomes a more likely scenario then this could explain not only the exceptional performance, but also the yellowing/mortality. The relatively high incidence of long internode growth habit could also be an indication for this possibility.

The spacing is about 4 x 4 metres and some lower, smaller diameter branch abscission is occurring. However on a significant proportion of stems heavy, and possibly persistent, branching is showing signs of development. The branching habit at this spacing, and in the absence of a competing nurse crop, will be followed.

Many trees have to be tied, as they are prone to blow over, presumably because top growth has not been matched by appropriate root system development. However as soon as they become wind-firm the posts are removed. This usually occurs when the trees are 6 - 8 m tall and > 10 cm DBH. A ca 1.5 m circle is kept free of grass around each tree by regular spraying with Roundup. The rest of the area is mowed and the grass clippings used as mulch. Kiwi fruit seed continues to germinate in the weed free circle immediately beneath the kauri canopy.

Acknowledgements

The authors would like to thank the owners, Mr & Mrs Sutton, for permission to measure the stand and their hospitality during time spent with them.