



Silvicultural Management of Blackwood

A Blackwood Industry Group (BIG) Workshop

30 November – 1 December 2000
Smithton, Tasmania

Cooperative Research Centre for Sustainable Production
Forestry and Private Forests Tasmania

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by Alan Brown

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Foreword

Declining availability of cabinet timbers from native forests has increased attention to their cultivation and to the management of native forests from which they may be obtained. Blackwood is a species of special interest- it is amenable to cultivation and management, it has an extensive natural range in eastern and southern Australia encompassing rural communities seeking to diversify land use and economic activity, it is well suited to high-value-added products, and it has an established favourable reputation as a furniture timber.

Relevant interest groups are widely dispersed in Australia and New Zealand, and there has been no focal point for strategic interaction or exchange of information.

The workshop which is the subject of this report is the second in a series intended to bring these interests together and to develop a basis for ongoing interaction and mutual assistance. A framework for this was established at the first workshop at Lorne, Victoria, in November 1996 in the form of the 'Blackwood Industry Group'. The second workshop was conducted under the auspices of this group. Further activity and the long-term outcome is in the hands of participants in this group.

The proceedings of the first workshop were not published but a summary is included in this volume, which provides a valuable overview of the present situation and potential developments.

The two workshops have been supported by funds from the Joint Venture Agroforestry Program (JVAP), and complement the project 'Silvicultural management of blackwood (*Acacia melanoxylon*) for growth, form and wood quality' (Project JVAP CPF-2A). The JVAP is an initiative of three R&D Corporations — Rural Industries, Land & Water Australia, and Forest and Wood Products. These Corporations are funded principally by the Federal Government.

This report, a new addition to RIRDC's diverse range of over 700 research publications, forms part of our Agroforestry and Farm Forestry R&D program, which aims to integrate sustainable and productive agroforestry within Australian farming systems.

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Peter Core
Managing Director
Rural Industries Research and Development Corporation



A rare and unusual early blackwood fall-front desk. Provenance – Port Arthur 1860s; Private collection Hobart. Value = \$25 000 (Sotheby's Sydney, August 2000) (Andy Warner)

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Executive Summary

- Thirty-two persons attended a two-day workshop, 30 November – 1 December 2000, in north-west Tasmania on ‘Advancing Blackwood Silviculture’. There were three formal sessions on the first day. These covered blackwood in native forest, in industrial plantations and in farm forestry, with a total of 13 presentations. In addition there was an after-dinner speech on blackwood as a world-class timber. During the last part of the first day, and on the second day, there were field visits to two native forests sites, to two industrial blackwood plantations, to a farm forestry blackwood planting and to Britton Bros Sawmillers Pty Ltd, the largest operation in Australia harvesting, processing and milling blackwood.
- Blackwood sawmilling commenced in the 1830s and expanded significantly in the 1880s with the introduction of steam-driven sawmills. However the history of the blackwood market is one of significant market declines, the latest being in the early to mid-1990s. At present Britton Bros cut 8000 m³ of blackwood and produce 2500 m³ sawn timber of all grades, around 30%-40% of that produced in Tasmania and Victoria combined. The market is static at present, partly because of limited promotion and the cyclical effects of fashion. One option for revitalising sales is to seek niche markets for small volume, high quality furniture production overseas. These are currently being sought.
- A review by Forestry Tasmania calculates a sustainable yield of blackwood from State forest of 8500 m³ per annum over the 65 yr from 1998. Additional volume from blackwood plantations established since 1990 is anticipated to be available from 2018.
- Most blackwood in native forest is associated with areas of a particular fire history and is linked to burns in 1740, 1851, 1861, 1897 and 1898. As there is little resource older than 250 yr, this may place an age limit on the viability of soil-stored seed. There is little relationship between the growth of blackwood and rainfall but it can be shown that there are critical lower temperatures for blackwood presence and minimum temperatures for the commencement of active growth.
- Wet sclerophyll forest dominated by *Eucalyptus obliqua* but with a large quantity of ground-stored blackwood seed has considerable potential to increase the quality of the blackwood resource. Over 500 ha of this type of forest has been fenced within one month of burning to prevent browsing by large animals, and this has resulted in a high stocking of blackwood seedlings with a thick nurse crop of understorey species. The blackwood has shown excellent form though some release is required to prevent these sites being dominated by eucalypts.
- As blackwood has little natural apical dominance, a crucial factor leading to good form as well as good growth is the correct light environment. While it is not yet possible to fully separate out the effects of above-ground competition (for light) and below-ground competition (for nutrients and water), it should be possible to manipulate that competition (from the eucalypts and understorey) to improve the crown dynamics of the blackwood while at the same time achieving a predictable branch-free bole.
- Blackwood was first planted in the Nilgiri Hills in India around 1842. Plantations were first established in South Africa in 1891 and in New Zealand in 1896. Plantations have also been established in exotic environments at lower latitudes, albeit at higher altitudes, but for utility rather than cabinet timber. Abstracts in Tree-CD for *Acacia melanoxylon* over the period 1939 to 2000 demonstrate a continuing and quickening interest in the species although *Acacia mearnsii* still receives more attention.
- In Tasmania, industrial plantations have been planted with nurse crops (*Eucalyptus globulus*, *E. nitens* or *Pinus radiata*) as a means of imposing good form through the encouragement of apical dominance. These nurse crops were selected for a commercial outcome but their rapid growth has led to eventual suppression of the blackwood. There is also very little nursing early in the rotation and some form pruning is still essential. Alternative systems, with the above nurse

crops but with five more closely-spaced nurse rows between each blackwood row and waste thinning to prevent suppression, and with closely-spaced shrubby species (*Pomaderris apetala* and *Melaleuca ericifolia*) with early growth rates that are similar to the blackwood, are being tested.

- As long as there is shelter, blackwood tolerates a wide range of sites. In New Zealand it has been successfully planted into existing native vegetation (no longer acceptable), mixed with exotics but with variable results, and in pure stands and agroforestry plantings. In general form pruning is always required to ensure good form. Around 3 m of crown should be left following lift pruning at age 4 and 6 yr to avoid deleterious effects on height and diameter growth.
- Twenty-five seedlots of blackwood were tested with and without *E. globulus* as a nurse crop to assess the expression of form and growth rate by provenance across the species. Form varied between the seedlots in a consistent way across two sites, though form pruning of even the best provenance would be required to achieve a satisfactory stocking of crop trees. Basal area and volume index were not substantially affected by the presence of the nurse crop at age six years although height growth was, on average, 15% greater in the presence of the nurse crop.
- Since 1982 Ian Brown, a New Zealand farm forester, has been planting small groups of blackwood without nurse crops in lower valley slopes and sheltered gullies. With various forms of intensive silviculture, including a comprehensive programme of form pruning, he is able to produce a 6 m stem by age 8 yr that requires no further maintenance until harvest. Form pruning includes leader training, the selection of the leading shoot each spring until the tree is 5-6 m in height and the simultaneous shortening of any vigorous competing branches to half their length; and clearwood pruning from age 4 yr that removes up to 40% of the foliage from the largest branches.
- Mature blackwood can be vegetatively propagated successfully to produce morphologically juvenile plants that are suitable for plantation establishment. Provenance, potting media, the presence of hormone and season significantly vary the number of viable shoots produced. Even where the root cuttings do not form independent

roots, the propagation technique can be used to 'juvenilise' the genetic material and allow stem-cutting techniques to be employed to generate suitable planting material, or to mass-produce the genotype.

- Blackwood responds well to clearwood pruning given a high standard of pruning. Stub cutting 15-20 cm from the stem avoids bark tearing and branch splitting. Branches should be removed before they exceed 30 mm in diameter. Given a clean cut, occluded bark should be contained within the defect core and not have an impact on recoverable clearwood volume. Discoloration associated with compartmentalisation of decay should also have a minimum impact on recovered volume, although there is evidence that a small percentage of any blackwood population is susceptible to decay.
- Tasmanian blackwood is considered to be harder than ash-type eucalypts but not as hard as peppermint eucalypts. Portable mills are available for sawing blackwood and cost about \$40-45 per hour. Stumpage for Category 4 logs (including better blackwood logs) is currently \$60-70 per cubic metre. For boards and flitches the following values apply: green select, \$900-1100; green feature, \$300-450; green veneer, \$1200+ per cubic metre. New opportunities for blackwood may be enhanced by recognising 'internationally accredited standards' for growing and harvesting, 'pruned standard certification' processes and on-line e-marketing, as well as a better understanding of how blackwood grows and can contribute to whole-farm financial returns. These aims can be assisted through the promotion and further development of the Farm Forestry Toolbox.

Chris Beadle
Andy Warner
 January 2001

1

New Developments in Native Forest Blackwood Silviculture

Sue Jennings and John Dawson

Forestry Tasmania

Blackwood (*Acacia melanoxylon*) commonly occurs as an understorey species within wet eucalypt forest (predominantly *Eucalyptus obliqua*) across the north-west of Tasmania. In some areas blackwood stocking is high and there is a large quantity of ground-stored blackwood seed. This is where there is the greatest potential to increase the blackwood resource. Surveys of regeneration show that if these areas are clearfelled and regenerated to eucalypt there is natural recruitment of about 70 blackwood stems per ha at age 7-11 yr (Jennings and Dawson 1998). If these eucalypt coupes are fenced to exclude browsing mammals, this can increase to an average of 2500 stems per ha at that age. Forestry Tasmania currently has over 500 ha of fenced eucalypt regeneration, with a commitment to fence another 750 ha over the next five years. If these areas are managed to maximise blackwood production they could significantly increase the quantity of blackwood sawlog produced.

How do we regenerate these areas?

Coupes with a high stocking of blackwood in the understorey are selected before harvest. They are clearfelled, burnt and aerially sown with a light rate (0.4 kg ha^{-1}) of *E. obliqua* seed. The coupes are fenced with wire netting within one month, to exclude browsing mammals (predominantly red-bellied pademelon).

The result is usually a high stocking of blackwood seedlings with a thick nursecrop of understorey species (mainly *Pomaderris apetala*) growing with the eucalypt regeneration.

How do we manage these areas for maximum blackwood production?

If the areas of fenced regeneration are allowed to grow on undisturbed, they become dominated by the eucalypts within the stand. The blackwood stems are nursed by the *Pomaderris* and show excellent form, but the blackwood growth is reduced by competition from both the eucalypts and the *Pomaderris*. In order to manage these areas for maximum blackwood

production, then some of this competition must be reduced.

(a) Blackwood release trial

A trial was established in 1995, in an area of six-year-old fenced regeneration. The eucalypt and *Pomaderris* competition were removed at different rates. The treatments (shown in Figure 1) were:

1. Control
2. Remove all eucalypts
3. Remove all eucalypts and all understorey competition within 10 m^2
4. Remove all eucalypts and all understorey competition within 40 m^2 .

Diameter growth increased dramatically with increased light availability (Fig. 2) from 0.8 cm yr^{-1} for control trees to 1.4 cm yr^{-1} in large gaps.

As with most thinning operations, height growth was not significantly affected by treatment (Fig. 3). However, the form of the blackwoods has been affected by treatment. This has been shown by an increased retention of branches on the trees with increased light availability. I am using the height of the lowest green branch to indicate the current potential sawlog height for each tree (Fig. 4).

However, despite a lower mean sawlog height, the sawlog volume of the trees was highest for the treatments with greatest light availability (Fig. 5).

But - how much did these treatments cost? What volume will they produce at harvest? What product are we trying to produce?

(b) Financial analysis

There are just too many variables and unknowns to try to predict the volume of blackwood that will be produced by these treatments. Forestry Tasmania is currently working on a growth model for blackwood, but even if this were available, the effects of the different levels of release cannot currently be predicted through-out the length of the rotation. Instead, a target-based approach was used in the financial evaluation – i.e., what volume of blackwood would be required to

cover the known costs of these treatments at different rotation lengths?

The release treatments were also compared with blackwood plantations, which is the other method which could be used to increase the blackwood resource.

Neilsen and Brown (1997) suggested that the likely product ratio from blackwood plantations at age 40 would be 40% Category 4. sawlog, 30% Utility log and 30% pulpwood. Stumpage rates from Jennings and Dawson (1998) have been assumed (\$62.00, \$30.00 and \$7.80 respectively). These were based on stumpage rates from the area in 1998. Combining these figures allows an estimate of \$36.14 to be made for the 'volume weighted stumpage price' for each cubic metre of timber harvested. The assumed costs ha⁻¹ are shown in Table 1.

Two rotation ages were chosen; age 40 to allow direct comparisons with plantations (Neilsen and Brown 1997), and age 60 to examine the effect of delaying harvest to achieve a larger diameter and possibly better quality sawlog.

To derive operational targets, the net present cost of each of the options was calculated for the range of discount rates from 2% to 10%. These costs were then divided by the 'volume weighted stumpage price' to estimate the volume of blackwood required at harvest time that would justify the cost of each treatment. For blackwood plantations, an offsetting revenue was

included at age 25 for the harvest and sale of the *Pinus radiata* nurse crop.

Figure 6 shows that there is a simple relationship between volume required, discount rate and the cost of treatment. The more intensive and hence costly the treatment, the greater volume of timber required at harvest. The exception to this is the plantation option, largely because of the revenue derived from the *P. radiata* nurse crop.

To establish whether these required volumes are realistic, they were divided by harvest age to derive a MAI (bole volume) for the commercial crop. These are shown in Table 2.

Neilsen and Brown (1997) assume a harvest volume of 450 m³ ha⁻¹ equating to an MAI (bole volume) of 11.3 m³ ha⁻¹ yr⁻¹. Using our methodology this suggests that plantations are viable up to discount rates of between 7% to 8%. If we assume that fenced native forest blackwood will grow at an MAI of at least 5 m³ ha⁻¹ yr⁻¹, then these four treatments reach the target at discount rates up to 4% to 6% depending on treatment.

Table 3 shows the MAI required at age 60 to justify each of the different treatments. It can be seen that realistic returns can only be achieved at this age for discount rates less than 3% to 4%. This delay in harvesting will be extremely hard to justify on financial grounds.

Table 1. Assumed cost per hectare of components for each treatment

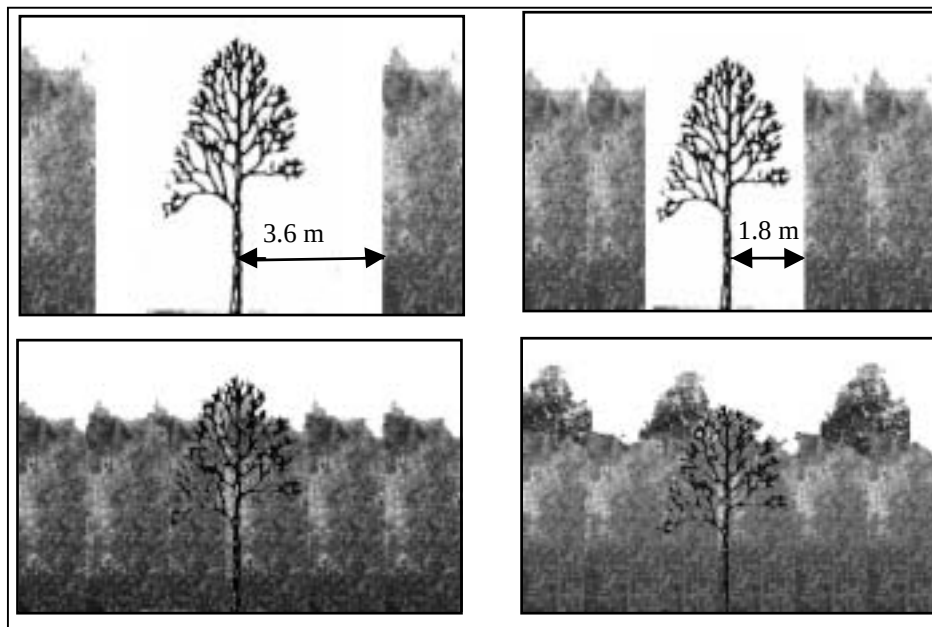
Activity	Year	Plantation	Treatment 1	Treatment 2	Treatment 3	Treatment 4
Establishment	0	\$2200	\$400	\$400	\$400	\$400
Fencing cost	0	\$300	\$300	\$300	\$300	\$300
Form pruning	5	\$550				
Prune 2.4 m	7	\$550				
B'wood release	8			\$500	\$900	\$1500
Prune 4.6 m	9	\$550				
Prune 6.4 m	11	\$550				

Table 2. MAI (bole volume) at harvest age 40 yr required to service the costs indicated in Table 1. The growth rates in shaded cells are likely to be exceeded in practice.

	3%	4%	5%	6%	7%	8%
Treatment 1	1.6	2.3	3.4	5.0	7.3	10.5
Treatment 2	2.6	3.7	5.3	7.6	10.9	15.6
Treatment 3	3.3	4.8	6.8	9.8	13.9	19.7
Treatment 4	4.5	6.4	9.1	13.0	18.3	25.9
Plantation	1.9	2.7	4.0	5.9	8.5	12.4

	2%	3%	4%	5%	6%	7%
Treatment 1	1.6	2.9	5.1	9.0	16.0	28.1
Treatment 2	2.6	4.6	8.1	14.1	24.5	42.3
Treatment 3	3.4	6.0	10.5	18.2	31.3	53.8
Treatment 4	4.7	8.1	14.1	24.2	41.6	70.9

Table 3. Required MAI (bole volume) at harvest age 60 yr



Key to treatments-

4	3
2	1

Figure 1. Blackwood release treatments

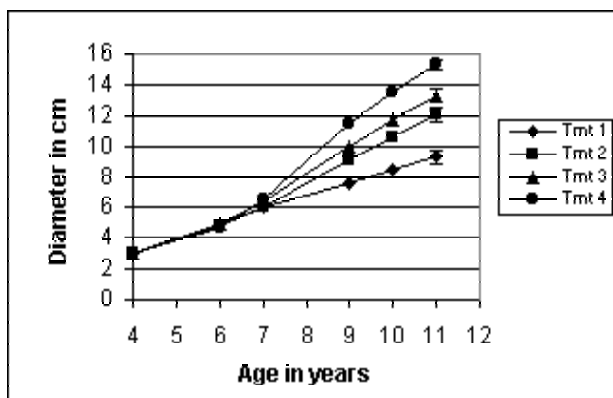


Figure 2. Mean blackwood diameter growth

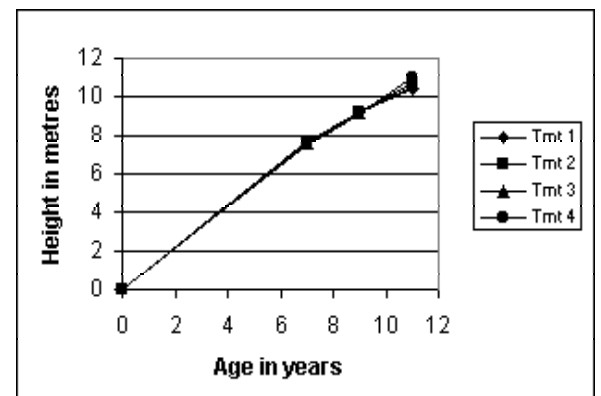


Figure 3. Mean blackwood height growth

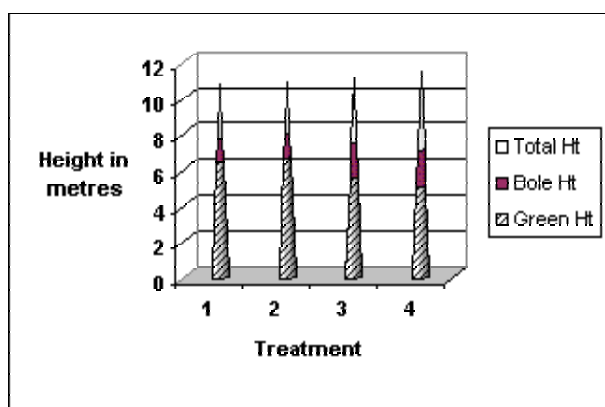


Figure 4. Mean blackwood sawlog and bole height

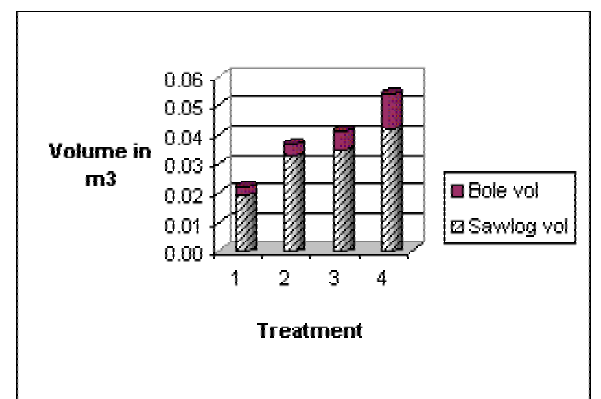


Figure 5. Mean commercial tree volume by product

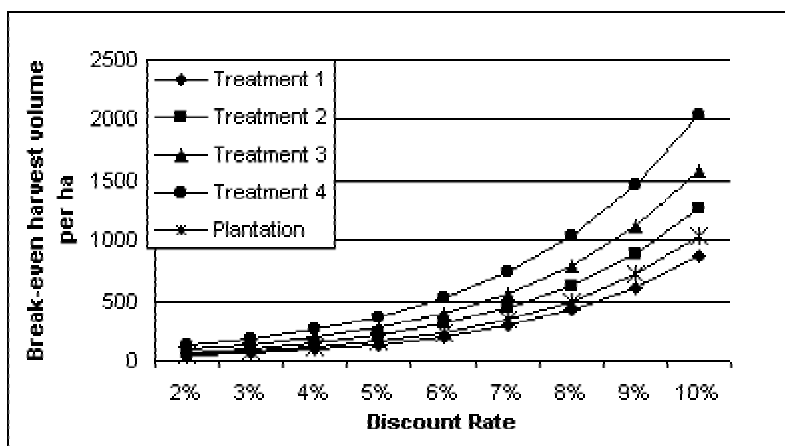


Figure 6. Break-even harvest volume per ha for each treatment at age 40

Discussion

It is possible to increase the quantity of blackwood grown in north-west Tasmania by fencing of regeneration on sites with ground-stored blackwood seed. This blackwood is additional to the current resource available from the blackwood swamps, the riverine rainforests and from wet eucalypt forests. It will provide flexibility for harvest, particularly in wet seasons.

Blackwood is very sensitive to the light environment. We can manipulate the growth-rates and form of young blackwood to a large degree.

While enough information is not currently available to allow us to make definitive statements on the productivity of blackwood release treatments, our analysis does indicate that the different treatments should be able to achieve returns of up to about 4% - 5% if MAIs of over $5 \text{ m}^3 \text{ ha}^{-1} \text{ yr}^{-1}$ can be achieved. This compares favourably with other extensive native forest investments. Although these treatments cannot compete with the plantation option, the *P. radiata* nurse crop

generates a large part of their value. There are also risk management advantages in using more than one method to deliver the final product.

However, there is some concern over the quality of product produced by rapidly-grown blackwood, and this applies equally to plantations and native forests.

Financial returns are a high priority when determining tending regimes. We need feedback from industry to determine what products they require, and what price is acceptable for a better product.

Acknowledgements

Thanks to Grant Denholm for his illustration of the treatments.

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2

Blackwood Regrowth and the Forest Light Environment - The Key to Good Form

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³Forestry Tasmania Project also supported by Natural Heritage Trust Farm Forestry Program

Introduction

In Tasmania, the blackwood (*Acacia melanoxylon* R. Br.) swamps of the north-west and the subcanopy component of blackwood which is obtained from harvested eucalypt forests, have together accounted for approximately 90% or more of the state's Special Species (Category 4) sawlog production during the past five years (Morris 1999). With an ample capacity for regeneration of blackwood from soil-borne seed in some of these forests (Jennings 1991), important silvicultural questions are raised, both by public forest managers and by smaller scale private growers. For example, how best to manage regrowth blackwood silviculturally, in conjunction with other management objectives (and constraints) for moist native forests in either public or private ownership, in southeastern Australia? Private forest landowners hold significant areas of disturbed or cut-over eucalypt forests in northern Tasmania. Much of this is only extensively managed for timber production and some, particularly in moist sites, is likely to be suitable for blackwood in complement with other species.

Form and growth habit in response to competition

Problems with blackwood silviculture originate in the uncertain transfer of silvicultural science and technologies developed historically for *Pinus* and *Eucalyptus*. This difficulty is compounded by an incomplete understanding of the broad ecological and physiological tolerances of blackwood compared to the above genera, and is coupled with the inherent genetic and morphological variability for which blackwood is renowned. (For details, see Neilsen and Brown 1997, Searle 1996).

In terms of growth phenology and regenerative behaviour in native forests, blackwood may be described as a subcanopy opportunist. In contrast to commercial pines and eucalypts, (and even related cabinetwood *Acacia* (e.g. *A. aulacocarpa*)), blackwood

is not by nature an early secondary species and nor is it strongly shade intolerant. Blackwood may persist at comparatively high stocking densities beyond the sapling stage in regrowth forests, without exhibiting strong patterns of self-thinning through either lack of light or other competitive influence (Jennings 1991). Like other tree *Acacia*, blackwood exhibits minimal, if any, shoot apical dominance. When grown in open conditions (with direct sunlight from the side and above), short stems and heavy lateral branches are often produced to support a broad, low, umbrageous crown with minimal central axis and little or no merchantable bole, as in Figure 1(a). By comparison, in small gaps in native regrowth forests, side light may be reduced to very low levels by dense foliage of competing canopy and subcanopy species and direct sunlight is usually incident only from above. The regrowth blackwood stem normally grows tall and straight to emerge above height-limited codominants, without persistence of lateral branches in the lower bole, Figure 1(b).

Objectives

Collaborative research in north-west Tasmania is testing the proposal that silvicultural management of sub-canopy light environment provides an effective opportunity for strong, positive control of factors affecting blackwood form and merchantability, especially branch habit, whilst at the same time providing acceptable or improved growth rates. University of Tasmania (CRC Forestry), Forestry Tasmania and University of Queensland are the project partners and additional support is received by way of small grant funding from the Natural Heritage Trust. Objectives are as follows:

1. Determine growth response of young blackwood to regrowth forest environment, including response to silvicultural treatment of woody co-dominant species and competitive light condition.



Figure 1. Contrast in blackwood (*Acacia melanoxylon*) stem form and branch habit according to competitive growth environment: (a, upper) open-grown blackwood at Launceston, northern Tasmania; tree height 10 m, crown width 12 m, estimated age 45 yr; compared with (b, lower) young regrowth blackwood at Togari, north-west Tasmania, age 10 yr, tree height 10 m, average crown width 2.4 m, branch-free bole 7 m and rising with height of dense subcanopy of codominant dogwood (*Pomaderris apetala*). (Views (a) and (b) not to scale; foreground stems removed in (b)).

2. Define competitive light environment for young blackwood regeneration, including light response to sub-canopy (small gap) treatment, based on:

- (a) Systematic measurement and analysis of sub-canopy photon irradiance during peak solar conditions (11 am – 2 pm AEST), from solar altitude to zenith;
- (b) Comparative analysis of full-sun vs. clouded conditions during maximal irradiance (early - mid summer) and continuously through the seasonal range;
- (c) Digital analysis of regrowth forest light environment using vertical hemiphoto (fish-eye) imagery to predict canopy light response to silvicultural treatment.

3. Determine crown, branch and stem dynamics of blackwood regrowth in relation to competitive light environment and interspecific competition of emergent eucalypts and densely stocked codominant species in the subcanopy e.g. *Pomaderris*, *Melaleuca* and *Leptospermum* spp.

4. Demonstrate an acceptable growth rate and enhanced quality of blackwood form and growth habit suitable for use as a premium commercial cabinetwood, with or without selective removal of competing eucalypts.

5. Determine optimal silvicultural strategies for blackwood and accompanying eucalypts (e.g. *Eucalyptus obliqua*) in moist regrowth forest.

6. Derive appropriate silvicultural lessons for growing blackwood in farm forests and plantations.

Results

The blackwood silvicultural experiment at Togari Cpt 21A, NW Tasmania provides a suitable basis for assessment and measurement of the regrowth forest light environment surrounding young blackwood regeneration in this moist eucalypt forest. (For description of the experiment and treatment details, see Jennings, this volume.) Preliminary analysis of blackwood growth and the surrounding, competitive light regime (e.g. as shown in Fig. 2), yields the following patterns of plant response:

During age 6-11 yr, stem diameter increment of regrowth blackwood (BW) increased significantly over control, by culling of competing regrowth eucalypts (see Jennings, Fig. 2.) Diameter response further increased with small gap clearance of the surrounding subcanopy of densely stocked woody codominants (*Pomaderris*, *Melaleuca* and *Leptospermum* spp.).

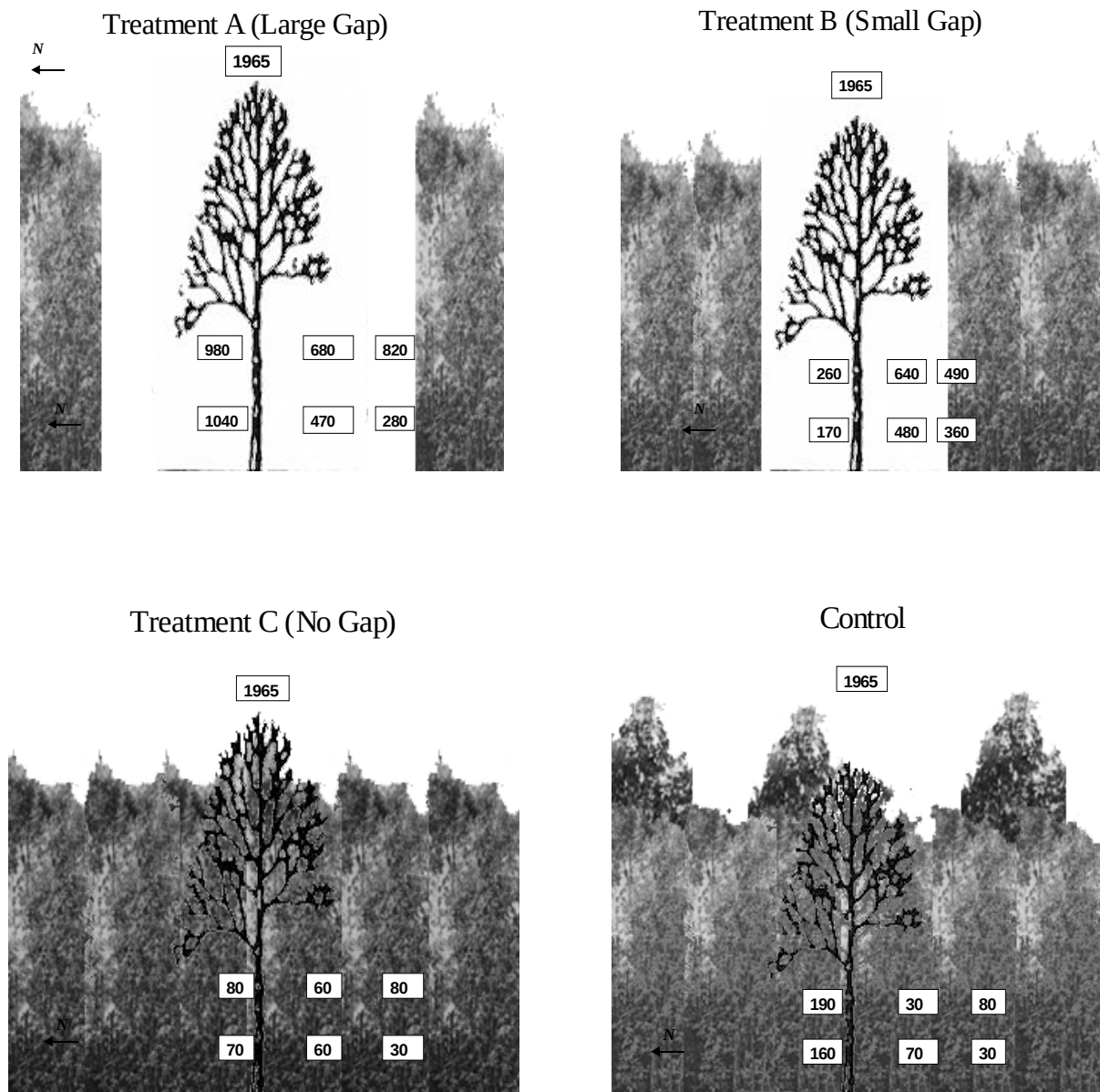


Figure 2. Light response to silvicultural treatment, November – December 1999, 4 yr after treatment. Boxed values show Mean Photon Irradiance (quanta PAR, $\text{mol} \times 10^{-6} \text{ m}^{-2} \text{ s}^{-1}$) for $n = 40-72$ instantaneous observations made in the regrowth forest understorey. Values were recorded systematically at 1.3 m and 4.0 m above ground, on several days during peak sunshine conditions, at or near solar noon (1100-1400 hr). Mean photon irradiance for full-sun conditions above the canopy is shown as $1965 \text{ mol} \times 10^{-6} \text{ m}^{-2} \text{ s}^{-1}$ during the period of understorey observations

Tree height was unaffected by gap treatment but height to lowest living branch (LLB), and therefore length of branch-free bole, was enhanced by retention of the dense subcanopy in the Control and Treatment C (each with no gap). Retention of the densely stocked woody co-dominants (in this case mostly *Pomaderris apetala*) as native nurse species significantly raised the height to lowest living branch of blackwood and hence branch-free bole at age 10 yr.

Preliminary light analysis (e.g. Fig. 2) indicates that blackwood light environment can be controlled through retention of densely stocked native codominants **of similar rate of early height growth to the regrowth blackwood**. At regrowth age 10 yr, during conditions of peak summer irradiance, subcanopy light levels beneath the crowns of the codominant nurse species were reduced to a mere 4.5% and 3.6% of open (above-canopy) conditions at 4.0 m and 1.3 m height above ground, respectively. In cloudy conditions which commonly prevail over blackwood forests of NW Tasmania, diffuse subcanopy irradiance further declined to 3.4% and 1.7% of open conditions, respectively.

Blackwood crown width (and diameter of lowest living branch) increased substantially in response to small gap clearance of the dense subcanopy of *Pomaderris* (Fig. 3(a), Treatments A and B). With retention of these densely stocked co-dominants as native nurse species, both frequency and size of lower branches of BW were suppressed (Fig. 3(b)). Small, dead branches were shed rapidly from the heavily shaded tree bole as the green crown was raised. With very low levels of both direct and diffuse sunlight beneath a continuous sub-canopy of broadleaved *Pomaderris*, (e.g. Fig. 2 and similar), senescence and subsequent abscission of lower branches were prompt and effective (at least during experimental observations from age 6 to 11 yr). Apart from the pronounced effects of silvicultural treatment on branch retention and length of branch-free bole, stem form remained generally high throughout age 6 - 11 yr, regardless of treatment.

Discussion

Lessons which are emerging from improved understanding of regrowth competition, (particularly multispecies, canopy - understorey interactions among regenerating taxa), are pointing to enhanced silviculture of this highly valued cabinetwood species, not only in regrowth forests, but in plantations. Early results indicate that improved silvicultural strategies for blackwood using dense subcanopy competition from native genera such as dogwood (*Pomaderris*) and tea tree (*Leptospermum* and *Melaleuca* spp.) will find particular application on suitable moist regrowth sites in both small scale farm forests and some publicly owned or corporate forests. Disturbed eucalypt forests on moist farm sites (e.g. on mid- to lower slopes and in well-drained gullies and river terraces) provide a particular

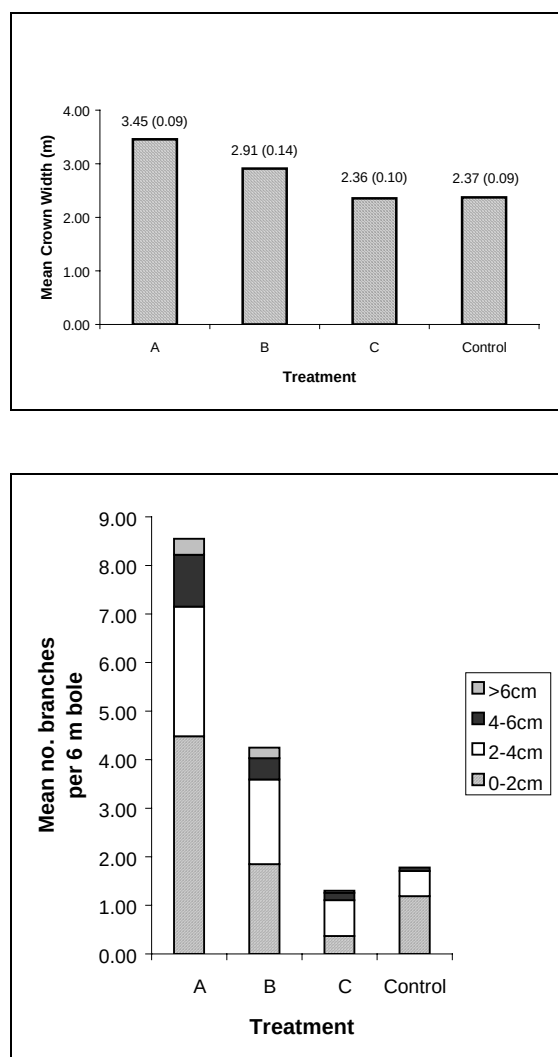


Figure 3. Growth response of *A. melanoxylon* to silvicultural treatment of regrowth eucalypt forest, showing (a, upper) mean crown width of blackwood at age 10 yr, with standard errors, and (b, lower) mean frequency and diameter distribution of branches per 6 m bole, at age 11 yr, (n = 27). Silvicultural treatments favouring single, naturally regenerated blackwood stems were applied in aerially seeded eucalypt regrowth forest at age 6 yr, at Togari Cpt 21A in NW Tasmania as below. (Treatment labels 1-4 in brackets correspond with Jennings, previous paper.)

- Treatment A (4) Culling of emergent eucalypts, plus clearance of understorey gap to 3.6 m radius surrounding each sample blackwood, (stocking density of blackwood equivalent of 250 s ha⁻¹)
- Treatment B (3) Culling of emergent eucalypts, plus clearance of understorey gap to 1.8 m radius surrounding each sample blackwood (stocking density of blackwood equivalent of 1000 s ha⁻¹)
- Treatment C (2) Culling of emergent eucalypts, with retention of closed subcanopy (no gap)
- Control (1) Eucalypts retained, with retention of closed subcanopy (no gap)

opportunity where close attention to management of early, interspecific competition is affordable and practical for a potentially high-value product of established value and charm.

Although it is not possible in the above experiment to separate entirely the effects of above- and below-ground competition, results demonstrate that native nurse species such as dogwood and tea tree offer a useful and effective tool for silvicultural management of blackwood light environment on suitable sites. Silvicultural intervention specifically to manage native nurse regeneration as well as competing eucalypts provides a powerful environmental lever on improving crown dynamics and branch habit of BW, without the cost of pruning. This is especially useful, as in the above trial at age 11 yr, the blackwood now shows evidence of overtopping the (height-limited) codominant nurse species to achieve a predictable branch-free bole of length 8-10 m (plus). On some sites, e.g. the swamp forests and riverine forests, the length of branch-free bole may be extended in this manner, to 12-15 m or more, depending on canopy height of the particular native nurse species at maturity.

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3

Blackwood Sawlog from State Forest

Bob Mesibov

Forestry Tasmania

Forestry Tasmania published in 1999 a review of the blackwood sawlog supply from State forest. A sustainable annual yield of $8500 \text{ m}^3 \text{ yr}^{-1}$ was calculated for swamp forest and arisings (mainly understorey blackwood in eucalypt production forest) over the 65 yr from 1998. Additional volume will be available beginning about 2018 from existing and new blackwood plantations, and from specially managed eucalypt regeneration areas.

The review was carried out by Geoff Morris of Forestry Tasmania's Planning Branch, and was part of a State requirement under the 1997 Tasmanian Regional Forest Agreement (RFA) to consider and possibly revise wood supply levels. Under the Tasmanian Forest and Forest Industry Strategy (TFFIS), the blackwood sawlog target for public land had been set at $10\,000 \text{ m}^3 \text{ yr}^{-1}$. A program of Intensive Forest Management (IFM) to be funded under the RFA was designed in part to help achieve the TFFIS target (RFA clause 77).

Blackwood sawlog has several State forest sources. The most important production areas are the blackwood swamps west of Smithton in the far Northwest, which over the last 5-10 yr have yielded 60% of the State's blackwood sawlog total. Following the creation of a number of 'post-RFA' reserves, the swamp production area totals 6500 ha, of which 13% is discounted for streamside reserves, very wet areas and *Eucalyptus brookeriana* patches. The discounted swamp production area is 5650 ha.

Yield predictions from the 5650 ha were modelled using inventory data from nearly 8000 assessment plots measured from 1972 to 1993. Swamps were stratified into 'stands', which are more or less contiguous patches of blackwood forest of similar age and structure. A growth model was devised which grows on individual 'stands' to harvest at a quadratic mean diameter $\geq 50 \text{ cm dbh}$. Sawlog volume was calculated as a linear function of stand basal area, different functions being used for different swamp areas. Harvest schedules were optimised to maximise and smooth out sawlog production over 70 yr.

Blackwood 'arisings' (logs incidentally obtained in the course of harvesting or conversion of native eucalypt forest) may provide as much as 50% of the annual yield

over the next 10 yr, declining to about 10% in the longer term. Small volumes will also arise from opportunistic harvest of blackwood-rich forest patches (mainly on the West Coast) and from selective logging of rainforest. When calculating sustainable yield at the State level, the contribution from these arisings was assumed to be constant after 2008.

Blackwood from IFM initiatives will come from 1000 ha treated over a nominal 5 yr. Current planning assigns 750 ha to fenced eucalypt regeneration and 250 ha to blackwood plantation. Blackwood from these sources and 900 ha of existing Crown plantations will contribute additional sawlog volume in the period 2018-2048.

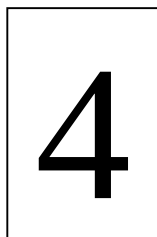
The supply review predicts that the TFFIS target of $10\,000 \text{ m}^3 \text{ yr}^{-1}$ will be achieved beginning about 2025 as sawlog from existing plantations comes on stream (see accompanying graph). The target will be exceeded for the following 20 yr, after which supply will drop to the sustainable swamps+arisings level of $8500 \text{ m}^3 \text{ yr}^{-1}$.

For the purposes of the review, 'blackwood sawlog' was defined using the current specifications for Category 4 sawlogs (minimum length 3.1 m, minimum small-end diameter 30 cm; form and defect limits also specified) and Utility sawlogs (2.5 m, 25 cm; form and defect considered). Swamp modelling projected the total sawlog to a small-end diameter of 25 cm, then split the volume according to the current harvest average of 78% Category 4 and 22% Utility. The $8500 \text{ m}^3 \text{ yr}^{-1}$ of sustainable yield thus consists of $6500 \text{ m}^3 \text{ yr}^{-1}$ of Category 4 sawlog and $2000 \text{ m}^3 \text{ yr}^{-1}$ of Utility sawlog.

The supply review also identified a number of ways in which blackwood volume forecasts could be improved. These will be introduced in the next review, to be carried out before the next five-yearly RFA review in November 2007.

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Britton Bros Pty Ltd

Donald Britton

Britton Bros Pty Ltd, Smithton

Introduction

The company is a family-owned third-generation business that has specialised in blackwood timber production for 90 yr. The core business has entailed harvesting, processing and marketing of Tasmanian blackwood.

The mill was based at Brittons Swamp until 1974, when it was moved to Smithton, a more central location suited to newly-developed South Arthur operations as well as ongoing North Arthur harvesting.

In 1977, Britton Bros purchased Kauri blackwood and special species rights which included an overall reduction in blackwood allocations pending sustained yield figures – to be finalised as a result of Blackwood Management Plan released in 1983.

In 1985, a longitudinal veneer plant for slicing blackwood was installed.

In 1999-2000, figures for proposed sustained yield were released.

We are currently installing a new automated boiler system to provide steam for kilns, reconditioning and progressive kilns.

In future, we plan to upgrade the sawmill to more effectively process smaller-diameter eucalypt and blackwood logs.

Historical production

Blackwood production in Tasmania commenced in the mid-1800s; logs from swamps at Circular Head have been utilised since 1885.

Significant market declines occurred during the depression years, in World War II and the mid-1950s to 1961, mid-1970s to early 80s, and early to mid-1990s.

Large quantities of staves were produced in mid-1950s for beer barrel cooperage, during a period of low demand for sawn timber.

The periods of limited availability together with good quality products possibly laid the foundation for the strength of the industry during the 60s, 70s and 80s, when quite a large blackwood manufacturing industry emerged– demand for product, and prices achieved, were acceptable.

The market has historically suffered from short periods of over-production and consequently reduced prices.

Generally 5-10 yr have been needed to recover from this situation.

Current production

Britton Bros produces annually about 2500 m³ of sawn blackwood of all grades; this could be around 30%-40% of the total blackwood production of Tasmania and Victoria. The species composition of current production is shown in Table 1.

Table 1. Species sawn

Species	Annual volume (m ³)
Eucalypt	11 000
Blackwood	8 000
Myrtle	3 000
Other (CTP, sassafras)	500
Total	22 500

Current useage

Solid timber

High-quality furniture is produced in small volumes in Tasmania and mainland States. Natural feature grade wood is used in specialty furniture lines. Other uses are–

- General joinery and carpentry, e.g. shop and hotel fit-outs;
- Solid-panel doors for kitchen fit-outs and renovations;
- Exposed feature flooring (either strip flooring or parquetry block);
- Feature wall lining in domestic house fit-outs; and
- Kitchenware products such as laminated blocks featuring end grain, and laminated solid bench-tops.

Veneer

Veneered panels (veneer over MDF or particle board) are used to supplement solid products in the applications listed above. Highly-figured veneers are prized for top-end furniture and specialty uses such as guitar manufacture.

Veneered panels are also used in office partitions etc.

Market difficulties

The blackwood industry in Australia is at present static, due in part to-

- (a) marketing difficulties and limited promotion, particularly to architects and specifiers;
- (b) cyclical effects of fashion – blonde and red timbers now have an increased market share; and
- (c) price-cutting in the market place: this rarely sells more wood in total; it merely reduces margins and therefore profitability.

Other factors are-

- A decline of the Australian furniture industry;
- The unpredictable nature of interior decorating trends, e.g. solid wood cupboard doors vs laminates, darker coloured doors vs light coloured doors, solid timber floors vs carpet, and wall lining vs plaster;
- An influx of cheaper stained furniture from overseas, e.g. rubber wood from Malaysia;
- The relatively small market in Australia compared to countries such as USA;
- The export price – high compared with tropical hardwoods, although comparable to US and European hardwoods.

Market place prices have changed little, if at all, in the last 10 yr, despite significant increases in costs. For numerous reasons producing blackwood sawn timber or furniture is very labour-intensive, and hence average costs of production are high.

Our company has weathered the extended price stagnation by installing more materials-handling equipment to reduce labour content, but we can only go so far at any one time to contain costs. We must stock on average \$½ million of logs, \$1 million of rack stock and \$1 million of pack stock; these investments (and accompanying costs) are vital to sustain the core of the blackwood industry.

Difficulties of wood characteristics in Australia or world markets

Colour varies from light golden teak to dark-brown walnut. The relatively small diameter of logs and poorer form results in a large volume of short, lower-grade material.

Export markets seek US-specification timber, i.e. 150 mm and wider and 2.1 m and longer, and long-term guaranteed supply.

In addition, the small volume of timber available (in global terms) reduces market potential.

Future markets

Re-vitalisation of Australian furniture industry is essential, e.g. through support of the Australian School of Fine Furniture. Other market opportunities are-

- Office furniture for State and Federal departments;
- Continued use in cupboard doors and solid feature flooring; and
- Greater usage in architect-designed offices, hotel fit-outs etc.

Our company is actively seeking overseas markets, and especially niche markets in Europe, New Zealand, USA or Asia that could use blackwood in small-volume, high-quality furniture.

We are currently using the University of Tasmania website (Timber Research Unit) to promote blackwood through the internet.

Common goals

Despite some gloom and doom, we believe the blackwood industry has a bright future, but we must address all the issues surrounding the entire industry - from the grower to the purchaser of the finished products.

We must work together as an industry to achieve adequate returns on our invested funds. There is no point in growing increased volumes of wood for a market that doesn't exist and vice versa, there is no point in developing and creating markets for a product that has insufficient supply of raw material. We must work together to harmonise all stages of production.

It is important to achieve this goal not only to ensure our profitability as processors, but more importantly to give current and potential growers the confidence to put trees in the ground for future generations involved in our industry. Likewise, growers must expect and achieve an adequate return on their investment. Expansion in this industry may well hinge on the success and rate of planting in plantations, which is still very much in its infancy.

While getting trees in the ground is important, we must not lose sight of the importance of growing a **quality** product. This must include acceptable colour, density and form – goals achievable given the appropriate research and development commitment. Experience with faster-grown regrowth timber in any species is that the resultant product is more open-grained, lighter in colour and much more defective than our naturally-grown native trees. Industry must adjust to these changing characteristics and strive to maximise quality.

Conclusion

Australian markets are and will continue to be cyclical.

Architects, specifiers and Government department purchasing personnel should be encouraged to buy Australian (particularly Tasmanian). Our product is

only a very small component of the overall industry – we must seek out and expand in the niche market area – we have to market the wood with vigour to get it back to its rightful place, and thus ensure its long-term future.

We should do this collectively as an industry, not as individuals.

A significant portion of Tasmanian blackwood production (up to 30%) has to be targetted to offshore markets; these markets are subject to ‘world’ quality, specification and pricing. Internet marketing will assist in sales, especially overseas.

Tasmanian blackwood (and supplies from elsewhere) has to come from high quality, sustainable and

appropriately certified forest production. Ideally wood should be medium-dark in colour and sawn from logs >60 cm mid-diameter, be they from plantations or native forest.

I would like to thank the convenors of this workshop for their efforts in bringing us together once again to openly discuss the various aspects of our industry - where we’ve been, where we’re at and most importantly, where we’re going.

Given the will and co-operation, I firmly believe the blackwood industry in Australia has a very good sustainable future.

5

Blackwood - An Historical Perspective

Alan Brown

CSIRO Forestry and Forest Products, Canberra

Introduction

The potential of blackwood was evident by 1900. By that time, it had already been successfully grown in several countries and timber production from native forests in Australia was well established. It is only in the last few decades, however, that its management and cultivation have been given serious attention in this country.

This quickening interest in blackwood is reflected in a rapid growth of the literature (Fig. 1).

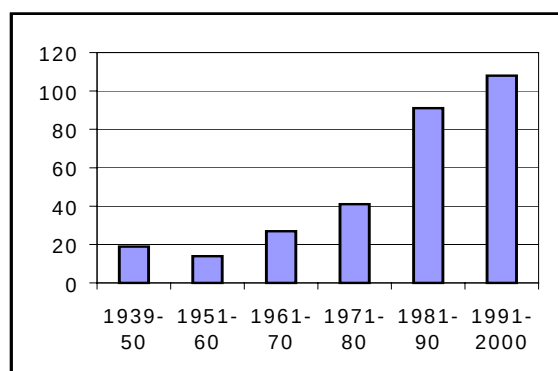


Figure 1. Abstracts in Tree-CD for *Acacia melanoxylon*

However, other species of interest in this region have appreciably more references (Fig. 2).

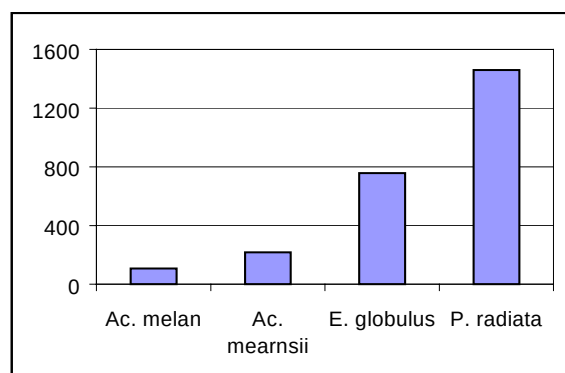


Figure 2. Abstracts in Tree-CD for 1991-2000

Early accounts of the species as an exotic are provided by Troup (1932) and Streets (1962), but by definition these do not describe its management in Australia – although there was probably little to describe apart from the progressive attrition of the resource through milling and clearing for agriculture. Troup does note, however, that its wood was ‘of very good quality, dark brown, beautifully mottled...exported and widely known in various parts of the world’. The species was not included in *Multipurpose Australian Trees and Shrubs* (Turnbull 1986), a book conceived as a first step in the forestry program of the Australian Centre for International Agricultural Research. In the revised volume *Australian Trees and Shrubs: species for land rehabilitation and farm planting in the tropics* (Doran and Turnbull 1997), however, it has a four-page entry. Further detail is available in *The Forestry Compendium* (CAB International 2000).

The first 100 years

Blackwood sawmilling in Tasmania commenced in the 1830s, and expanded significantly in the 1880s with the introduction of steam-driven sawmills (Hickey and Wilkinson 1999). The quality of the wood was recognised early. Baker (1919) considered it to be ‘Probably one of the most gorgeously figured woods of the world’, and he ranked it next to red cedar in usefulness. Subsequently Swain (1928) wrote ‘The figured and fiddle backed blackwood of Tasmania is incomparable, and not even the most beautiful American walnut can vie with it in elegance’. He did not include the species, however, among the Queensland timbers described in his book, suggesting that there was little awareness of the occurrences in that State.

The tree was introduced to the Nilgiri Hills in India about 1842; subsequently some trees reached a height 34 m at 40 yr. In South Africa, individuals were planted from 1878, and plantations started 14 yr later in 1891. Troup (1932) considered the tree to be ‘of major importance’ in that country. In Kenya, plantations commenced in 1912. In Sri Lanka, the first introductions were in the 1860s (Midgley and Vivekanandan 1987), and plantations commenced in 1918; about 1200 ha in mixture with eucalypts and cypress were established between 1929-1935. From

1936 the use of the species was dropped because of browsing by deer. Initial growth in several of these countries is reported to be quite rapid - up to 3 m in each of the first two years. The latitude of the planting sites in India, Kenya and Sri Lanka is low, but the sites are at high elevations – 1500 to 2400 m. Many of the plantings seem to have been undertaken to provide utility wood rather than cabinet timber.

In New Zealand, planting near Rotorua began in 1896 (Gleeson 1986), and about 30 ha were established in mixture with other acacias in 1906, the best trees reaching 23 m at 46 yr. Poor form was the most evident problem (Streets 1962).

As for native forests in Tasmania, the Forestry Department attempted to assess the blackwood stands remaining in the 1920s, but efforts lapsed during the Depression of the 1930s.

The last 50 years

Around the time of the Second World War, the prospects of improving the genetic quality of planted trees were widely recognised, and tree breeding programs commenced for major species. Although blackwood was not being planted in Australia at that time, Fielding (1948) recognised the high value of figured trees of blackwood, and undertook preliminary work to capture the genotypes of outstanding trees by vegetative reproduction.

Prospects for management of native stands in north-western Tasmania were significantly enhanced in the 1970s by the dedication of about 6000 ha of swampland to State Forest, and subsequently in 1982 by the establishment of a Swamp Working Circle of 7880 ha operating on a 70-yr rotation (Hickey and Wilkinson 1999). Silvicultural systems were developed for blackwood in swamps, in riverine stands and in wet eucalypt forests (Forestry Commission 1991), and these have been progressively refined (e.g. Jennings 1998).

A Tasmanian silvicultural regime for growing commercial plantations of blackwood with a nurse crop of radiata pine was described by Neilsen *et al.* (1998), and at that time 540 ha of a total of 800 ha had been established with that nurse crop. Five hundred blackwood (each third row) are planted with 800 radiata pine per hectare; the blackwood is form pruned to remove any branches larger than 30 mm in diameter and then both species are lift-pruned to 6.4 m to produce sawlogs.

Increasingly results of research on the cultivation of blackwood in States other than Tasmania are now becoming available - e.g. Borschman and Lamb (1998) reported that blackwood planted in 1990 in mixed stands in SE Queensland had grown well.

The potential of blackwood in New Zealand has received a lot of attention for several reasons - the

desire to find species that might dilute the predominance of radiata pine in the plantations of that country, the very high potential value of the wood (ranked with American black walnut by Burdon and Miller in 1995), the good match between climates in New Zealand and those of SE Australia, and the interest of landowners in farm forestry. Thus there has been a substantial flow of information, relevant to Australia and indeed other countries, from New Zealand research and operations on blackwood. Gleeson's 1986 review is excellent; follow-up includes the presentation by Ian Nicholas to the Lorne workshop in 1996.

In South Africa, the promise seen by Troup in 1932 was not fulfilled: in 1962 Streets reported that the tree was now a minor species, frequently with poor form. Indeed reports from a number of countries indicate waning interest, because of a variety of factors including heavy browsing (especially by deer), poor form and damage by the mistletoe *Loranthus*.

There are relatively few reports of blackwood in South America, perhaps in part because literature from that region is less accessible than that from English-speaking sources. Gleeson (1986) noted that operational plantings had been reported in both Argentina and Chile. Burdon and Miller (1995) commented that the problem of poor form of blackwood in NZ often does not appear to occur in Chile. Opportunities for more extensive use are being examined (Ramirez 1998).

New players

In the last two decades the pace has quickened, at least partly due to the appearance of new institutional players in Australia. Most of these reflect an increased Commonwealth role in forestry.

The Australian Centre for International Agricultural Research (ACIAR) was established in 1982, and developed a number of forestry projects around the genetic resources of Australian trees, including acacias. A series of associated workshops (1986, 1991, 1997) has provided stimulus and opportunity for research workers to report progress including field trials of species and provenances, studies of genetic variation and symbionts, and silvicultural practices. Results were disseminated in published proceedings as well as providing the basis for the major collations of Doran and Turnbull (1997) and CAB International (2000).

The 1987-88 'Helsham Enquiry' (Tasmanian Public Land Use Commission 1996) led to agreement between the Commonwealth and Tasmania regarding forest tenure and the payment of \$50 million compensation to the State. Elements of the resulting Forests and Forest Industry Strategy 1989-90 included the implementation of a Blackwood Management Plan with a supply target of 10 000 m³ annually from public

forests, and a level of royalties that would provide satisfactory returns to growers. The Helsham funds, among other things, have significantly assisted research and operations on blackwood.

The Joint Venture Agroforestry Program was established in 1993, jointly funded by the Rural Industries, Land and Water Resources and Forest and Wood Products Research and Development Corporations (RIRDC, LWRRDC and FWPRDC). This Program has supported individual research projects involving blackwood, as well as the first Blackwood Workshop at Lorne in 1996 (Annex A). This meeting was notable in bringing together a comprehensive range of contributions on topics ranging from genetics to marketing, including an overview of developments in New Zealand. It is regrettable that no proceedings were published subsequently, but this meeting (November 2000) is a direct outcome of that at Lorne, and there will be a published record on this occasion. (Some information prepared for Lorne has subsequently appeared in print, e.g. Searle 2000).

The establishment of the CRCs for Tropical Rainforest Ecology and Management in 1993, and for Sustainable Production Forestry in 1997, increased relevant research capacity in NE and SE Australia respectively.

The emergence of the Australian Forest Growers and associated agroforestry conferences has provided important new communication pathways to landowners. In New Zealand, the Farm Forestry Association and the Grasslands Association are two groups interested in the potential of blackwood.

Conclusion

This Smithton workshop is an encouraging indication that blackwood forestry is alive and well, despite the time it has taken for the Blackwood Industry Group to meet again following the Lorne workshop in 1996. Both operations and research over the last few years have arguably been at their highest level ever. Of course some problems do remain, and these should be assessed and useful approaches identified by this meeting and its successors.

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Growing Australian Blackwood for Timber

A Strategic Workshop

A report for the
RIRDC/L&WA/FWPRDC
Joint Venture Agroforestry Program

by
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Executive Summary

1. Blackwood (*Acacia melanoxylon*) is one of a very few species which have potential to produce high-quality cabinet wood in south-eastern Australia. It occurs from Tasmania to Cape York, mainly on the coastal escarpment and tablelands but extending to coastal lowlands in the south. The wood is highly valued for furniture and veneer. Future supplies are expected to come from both native forests and planted trees. The quality of the wood, as determined by density, colour and figure, varies greatly.

2. Processing and marketing in Australia has been fragmented. The number of manufacturers of blackwood furniture in Tasmania has declined sharply in the last decade (>12 to 3), and attempts by a Melbourne furniture retailer to develop a vigorous cooperative approach to marketing and retailing have had only limited success.

3. The species has been cultivated in several overseas countries, but particularly in New Zealand and South Africa. Accounts of experience in those countries are available. A 'Special Purpose Species' research group, the interests of which include blackwood, exists in the Forest Research Institute at Rotorua, and has an associated national network, 'AMIGO'.

4. Research in Australia has been limited. An attempt was made around 1950 to select and propagate trees

with fiddleback grain, a highly prized feature, but the effort was too small to yield useful results. The species has been included in the ACIAR Forestry Program from the early 1980s. Provenance trials have been established in Tasmania, Victoria (24 provenances), ACT, Queensland and China. Forestry Tasmania is undertaking silvicultural studies, and an account of Tasmanian experience is available.

5. Blackwood cultivation does experience significant problems. No genetically-improved stock is available at present, and indeed even the basis for any improvement is not well established. Browsing by marsupials is a real problem. Stand management is more complex than for species such as radiata pine. As the crop is a long-term one aimed at a high-value product, there is particular merit in getting the genetics and silviculture right.

6. The strategic interests of growers, processors and researchers scattered in Australia and New Zealand could undoubtedly be furthered by an active and representative contact group. There has been no clearly-recognisable vehicle for this contact.

7. The workshop which is the subject of this report was organised by Rowan Reid, Suzette Searle and Alan Brown. **The workshop established a 'Blackwood Industry Group' as a basis for on-going, effective contact.** The workshop, held at Lorne, Victoria, 20-22 November 1996, attracted more than 40 participants. The program included an inspection of native forests (Otway Ranges) and plantations (Bambra Agroforestry Farm), and blackwood milling and drying (Otway Hardwoods Sawmill). Presentations covered biology, resource availability, silviculture, timber quality, uses and markets, retailing; and R&D in Australia, New Zealand and elsewhere. Three discussion groups examined communication, research needs and a mechanism to maintain contact and pursue the preceding topics.

8. **The initial 11 members for the Group are representative of major geographic areas, industry sectors and government agencies.** Rowan Reid was asked to convene an inaugural meeting of the Group to address issues such as incorporation, secretariat arrangements, a network database and modus operandi. **A summary of the workshop and proposals for the first meeting of the Group were circulated to workshop participants on 14 April 1997.**

6

Blackwood - Defining the Options: New Zealand Experience

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Introduction

Blackwood (*Acacia melanoxylon*) research in New Zealand has progressed in terms of silvicultural evaluation since the workshop at Lorne in 1996 (Nicholas 1996). Major developments have been in the evaluation of pruning data from the regime trial series established in 1987, further testing of form pruning options and the development of a growth model. This paper addresses some of the findings from the data collected and analysed since 1996.

Defining the options

The options in blackwood management revolve around siting, growing system, pruning (for form and clearwood), thinning and final crop stocking. The *Forest Research* regime trial series has established a strong database for silvicultural evaluation, especially for pruning and thinning.

Regime trial series

In 1987 Forest Research established a series of five regime trials to provide a detailed test of blackwood growth response to various pruning and thinning treatments across a range of final crop stockings (75, 125, 200, 300 and 425 stems ha⁻¹). Half the plots were thinned to final crop at age 6 yr and the others thinned at ages 4, 6 and 10, with a final thinning scheduled for age 18 yr.

Three clearwood pruning treatments were applied at age 4 and 6 yr leaving 1.5, 3 and 6 m green crown after each pruning lift. An annual winter form prune with a 30 mm branch gauge has been applied from age 3 yr. A final variable-lift prune to 6 m (where growth was sufficient) was conducted on 4 of the 5 sites at age 10 yr.

Siting

A survey of blackwood plantings at 69 North Island sites showed that shelter had a positive effect on bole length and tree height, and that blackwood was tolerant of wide-ranging site conditions (FRI 1978). Blackwood

grows well on moist fertile sites, but can also tolerate peaty or clay soils (Mortimer and Mortimer 1984; Nicholas 1991).

Although blackwood has a reputation for being very site tolerant, care is needed in siting the species for plantation forestry to ensure acceptable growth rates. In the five North Island regime trials, best growth occurred in a sheltered valley bottom site, and poorest growth on an exposed ridge site with clay soil. At age 11 yr, individual plot MTH¹ across the five trials ranges from 5.1 m on the poorest and most exposed site to 16.5 m on the best site.

Growing system

(i) Planting in existing vegetation

Early plantings of blackwood to enrich native forest have been quite successful (FRI 1983), but for some time in New Zealand the concept of enriching indigenous forest or scrub with an exotic species has not been acceptable. Research on the East Coast of New Zealand's North Island has investigated the influence of lane width (formed in existing native scrub cover) on growth and form (Herbert 1994). The results show that the control of stem form is directly linked to surrounding vegetation height (G. Steward *pers. comm.*).

(ii) Mixed with exotics

In New Zealand the results of growing blackwood in mixtures with exotic species are variable. Some very good examples exist, but also several disasters have been recorded, usually because the 'trainer' species has suppressed the blackwood, rather than improved its form. Mixtures remain a management option that requires considerable research before recommendations can be made on appropriate species and planting spacing. The potential difficulty with mixtures is that the growth rate of the 'trainer' species can vary from site to site and this directly influences the management of the mixture and the ultimate success of the system.

¹ MTH - Mean Top Height – the average height of the 100 largest diameter trees per hectare

(iii) Pure

Data and observations from within the *Forest Research* regime trial series indicate that single-species plantations of blackwood can be successfully established, and managed, to produce clearwood with intensive silviculture and careful siting.

(iv) Agroforestry

Studies have shown that blackwood plantations (at a relatively young age) have higher relative understorey pasture yields than *E. nitens* and *P. radiata*. Power *et al.* (1999) reported that decreased light levels reduced the populations of leguminous pasture species but that greater pasture production under *A. melanoxylon* suggested that N supply from the nitrogen-fixing blackwood was a likely cause of the difference in understorey pasture production between the tree species.

Form pruning

When open-grown pure plantations are established for clearwood production, the need for form pruning is clear. Analysis of form pruning trial data in the early 1990s concluded that the annual removal of branches >30 mm diameter using a branch gauge was the most practical method of pruning to improve form (Nicholas *et al.* 1994; FRI 1995). This research was based on winter pruning, but double summer pruning can also be very effective at improving stem form Brown (1995).

To explore these different approaches a replicated form pruning trial was established in a one-year-old blackwood plantation in 1995 at Paengaroa, Bay of Plenty, North Island, to test a range of treatments (Table 1).

Growth

Stems within the unpruned control treatment of the form pruning trial were significantly taller than all other treatments after 6 yr growth (Table 2). The breast height (1.4 m) diameter (DBH) of the trees in the control treatment was also larger than that of trees in other treatments, but only significantly larger than that in the two 30 mm branch gauge treatments.

Form

Form was scored on a scale from 1 (very poor) to 9 (excellent form). The best mean form scores were recorded for the July biennial 20 mm gauge treatment (Treatment 6) and the November annual 30 mm gauge treatment (3) (Table 2). The form scores were significantly greater under these treatments than under the July annual 30 mm gauge treatment (2), tipping (1) and the unpruned control (7), but did not differ significantly from the July biennial 30 mm gauge treatment (4) or the July annual 20 mm treatment (5).

Occurrence of crop trees

The percentage of acceptable crop trees (selected for form and diameter) before thinning at age 6 yr was highest for the July biennial 20 mm gauge treatment (6) and the November annual 30 mm gauge treatment (3), and significantly better than only the tipping treatment (1) (Table 2). All other treatments including the control (7) had a similar percentage of acceptable crop stems, suggesting that form may also be influenced by factors other than management alone on this fertile sheltered site.

Branches per tree

The number of branches per tree removed in the butt log clearwood lift (generally 5.5-6 m) at age 6 yr was recorded.

Table 1. Pruning treatments in Paengaroa form pruning trial

Treatment No. and code	Timing	Gauge size	Season
1. Tip-Nov/Feb	Double annual tip pruning*	na	November and February
2. A30-Jul	Annual	30 mm	Winter (July)
3. A30-Nov	Annual	30 mm	Summer (November)
4. B30-Jul	Biennial	30 mm	Winter (July)
5. A20-Jul	Annual	20 mm	Winter (July)
6. B20-Jul	Biennial	20 mm	Winter (July)
7. Control	No pruning	na	na

*Previously tipped branches still competing halved if basal diameter >20mm

Table 2. Growth and form results from form pruning trial at age 6 yr*

Treatment No. and code	Ht (m)	DBH (cm)	Form (1-9)	Occurance of crop trees (%)	Branches/ tree (n)
1. Tip-Nov/Feb	8.36 b	15.80 ab	5.60 b	47.5 b	40 a
2. A30-Jul	8.31 b	13.71 b	5.65 b	52.5 ab	27 c
3. A30-Nov	8.23 b	13.91 b	6.33 a	57.5 a	21 d
4. B30-Jul	8.22 b	15.28 ab	5.83 ab	52.5 ab	33 b
5. A20-Jul	8.09 b	15.35 ab	6.00 ab	50.0 ab	21 d
6. B20-Jul	8.43 b	14.88 ab	6.40 a	57.5 a	29 bc
7. Control	8.99 a	17.32 a	4.88 c	52.5 ab	43 a

*For each factor, values followed by the same letter do not differ significantly ($p=0.05$)

The least number of branches removed in this operation was in the November annual 30 mm gauge treatment (3) and the July annual 20 mm gauge treatment (5); these two had significantly less than all other treatments (Table 2). The two treatments that had significantly more branches to remove at this lift were the tipping (1) and control (7) treatments. However, tipping has demonstrated excellent form control at an early age in many locations (I. Brown *pers. comm.*).

Form pruning trial conclusions

In conclusion the form pruning treatments have all compromised growth, especially for height and to a lesser degree diameter (Table 2). The best form improvements resulted when the July biennial 20 mm gauge treatment (6) was applied, although the November annual 30 mm gauge treatment (3) was also successful, but the latter had fewer branches to remove at clearwood pruning.

The standard form pruning treatment recommended prior to analysis of this trial, the July annual 30 mm gauge treatment (2), yielded similar results to several other treatments, although minor improvements in form may justify a move towards pruning in November. There appeared to be no obvious benefit in reducing gauge size from 30 mm to 20 mm, although diameter growth was reduced less when the 20 mm treatments were applied. No clear differences between biennial compared with annual treatments were revealed by this trial.

Regime trial results

Green crown removal

To determine the effects of varying levels of green crown removal, the regime trials included three pruning treatments applied at ages 4 and 6 yr, leaving 1.5, 3 and 6 m green crown at each lift. Pruning intensity treatments within the regime trial series show

a significant treatment effect on MTD² and a lesser, yet significant, effect on MTH³ at each pruning event (Table 3).

These results show that the pruning treatment of leaving 1.5 m green crown at age 4 and 6 yr resulted in a significant depression of DBH and height increment when compared with the more conservative 3 m or 6 m green crown treatments. This depression in growth, however, was restricted to only the year following the pruning treatment. By 11 yr of age, the most severe pruning treatment (1.5 m green crown remaining) had significantly reduced both height and diameter growth compared to the leaving 6 m green crown (Table 3). The less severe pruning treatment (3 m green crown remaining) had no significant effect compared with leaving a 6 m green crown.

As the DOS⁴ values assessed in the trial have yet to be compared across treatments, the absolute amount of DOS reduction from early and hard pruning is unknown.

Green crown removal conclusion

Although the influence of pruning intensity on regime economics is unknown, it appears reasonable to recommend leaving 3 m green crown at each clearwood lift up to age 6 yr. This treatment appears to result in a minimal reduction in growth and is likely to achieve a reasonable DOS.

Thinning

Diameter and height data at age 11 yr were analysed across all five regime trial sites combined (Table 4) and also for the Whakarewarewa trial alone using a split-plot ANOVA and least significant difference (LSD) test for each factor.

The factors analysed in the ANOVA were site, timing of thinning, final crop stocking, and pruning. (Because of the split-plot nature of the trial design, the test for pruning was more sensitive than the tests for thinning or stocking.)

Site

The regime trials were established on selected sites of varying quality to ensure the data collected reflected a breadth of growth rates. As shown in Table 4, this was certainly achieved with two sites significantly different from the others for height growth. Diameter growth was also significantly different between sites with only two of the five sites similar in diameter at age 11 yr.

² MTD - Mean Top Diameter – the diameter at breast height of the 100 largest diameter trees per hectare

³ MTH - Mean Top Height – the average height of the 100 largest diameter trees per hectare

⁴ DOS – (Stem) diameter over (pruned branch) stubs

Stocking

Final crop stocking treatments had no significant effect on diameter at age 11 yr (Tables 4 and 5). Stocking had a weak effect on height, with taller trees measured at the higher stockings. This was evidenced by the significant difference between 125 stems ha⁻¹ and 425 stems ha⁻¹ (Table 4). Also, when stocking was fitted as a linear covariate in the model, it was highly significant ($p=0.0026$), confirming the positive effect

of stocking on height. This effect was not significant within the Whakarewarewa trial (Table 5).

Timing of thinning

Stem diameters at age 11 yr showed no significant differences between thinning to waste to final crop levels at age 6 yr, compared to the multiple thinning treatment (Tables 4 and 5).

Table 3. Mean MTD and mean MTH annual increment from ages 3-11 yr and mean DBH and mean Height at 11 yr*

Increment period	Mean top diameter (MTD) for pruning treatment-			Mean top height (MTH) for pruning treatment-		
	1.5 m green crown	3 m green crown	6 m green crown	1.5 m green crown	3 m green crown	6 m green crown
3-4 yr	2.23a	2.23a	2.23a	0.78a	0.82a	0.78a
4-5 yr	0.81c	1.44b	1.61a	0.63b	0.74a	0.74a
5-6 yr	1.95a	2.16a	1.99a	0.73a	0.76a	0.75a
6-7 yr	0.62c	1.34b	1.66a	0.84b	1.13a	1.04a
7-8 yr	0.68a	0.73a	0.81a	0.70a	0.72a	0.75a
8-9 yr	1.25a	1.13ab	1.04b	0.76a	0.71a	0.75a
9-10 yr	1.81a	1.66a	1.70a	0.65a	0.69a	0.72a
10-11 yr	1.72a	1.49ab	1.42b	1.01a	1.02a	1.12a
Mean DBH.or.Ht at age 11 yr	14.48b	15.84a	16.02a	9.14b	9.69a	9.79a

*Values within each increment period for each factor with the same letter are not significantly different ($p=0.05$)

Table 4. Analysis across all sites, age 11 yr*

Factor	Level	Mean diameter (cm)	Mean height (m)
Site	Cumberland	14.39c	8.59b
	Hunua farm	19.26a	10.88a
	Hunua forest	9.93d	5.88c
	Okareka	17.44b	11.15a
	Whaka	16.17b	11.19a
Timing of thinning	Early (6 yr)	15.69a	9.20b
	Multiple (6 & 10 yr)	15.19a	9.87a
Final crop stocking#	75 stems ha ⁻¹	15.08a	9.13ab
	125 stems ha ⁻¹	14.86a	8.95b
	200 stems ha ⁻¹	15.82a	9.66ab
	300 stems ha ⁻¹	15.69a	9.78ab
	425 stems ha ⁻¹	15.75a	10.16a
Prune	1.5 m green crown	14.48b	9.14b
	3 m green crown	15.84a	9.69a
	6 m green crown	16.02a	9.79a

*For each factor, values followed by the same letter do not differ significantly ($p=0.05$)

#Half the trial plots are currently at double this stocking

Table 5. Analysis of Whakarewarewa trial, age 11 yr*

Factor	Level	Mean diam. (cm)	Mean height (m)
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Timing of thinning	Early (6 yr)	15.81a	10.54b
	Multiple (6 & 10 yr)	16.52a	11.84a
Final crop stocking#	75 stems ha ⁻¹	15.81a	10.78a
	125 stems ha ⁻¹	15.66a	10.71a
	200 stems ha ⁻¹	16.79a	11.54a
	300 stems ha ⁻¹	16.42a	11.43a
	425 stems ha ⁻¹	16.16a	11.48a
Prune	1.5 m green crown	14.87b	10.64b
	3 m green crown	16.86a	11.47a
	6 m green crown	16.78a	11.46a

*For each factor, values followed by the same letter do not differ significantly (p=0.05)

#Half the trial plots are currently at double this stocking

However, the multiple thinning treatment produced a significant increase in height ($p = 0.023$) (Tables 4 and 5). The multiple thinning treatment has the advantage of carrying more trees to later ages as an insurance against mortality within a plantation.

Data collected over 16 yr from two other thinning trials have demonstrated that blackwood can ultimately respond to thinning to low stockings with increased diameter increment. The response, however, was weak, despite a wide range of final crop stockings ranging from 192 to 1392 stems ha⁻¹ being evaluated in one of the trials. Tree quality, measured as bole height to major leader defects, was not influenced by stocking within either thinning trial (unpublished data).

Growth model

A blackwood growth model that predicts total standing volume per hectare has been developed using the New Zealand regime trial and Permanent Sample Plot data. Although this data set, based on 1722 measurements from 229 plots, covers ages from 3 to 34 yr, most of the data are from younger stands (Berrill *et al.* in prep). The lack of older data from well-sited stands may result in prediction errors for rotations over 35 yr. A limited test of overall model performance has indicated that volume predictions were variable, but unbiased overall. Independent data, especially from older trees in new plots and/or new measurements within older existing sample plots, must be collected before a thorough validation can be undertaken. The model can be used to evaluate regime scenarios to determine the outcome of silvicultural decisions. Data and unvalidated growth model predictions indicate that low final crop stockings may be required to produce large logs within an economically acceptable timeframe.

Economic evaluations

The economics of growing blackwood have been evaluated in a number of studies (Cavanna and Glass 1985; Herbert 1994; Thorrold *et al.* 1997). Depending on the data inputs and assumptions made, Internal Rates of Return (IRR) ranged from 5% to 8%. However, most authors agree that the intensive silvicultural management required to grow blackwood for clearwood and the relatively low recovery of large prime sawlogs per hectare can only be offset by higher timber returns than are generally realisable in today's market. The lack of information on management costs and consistent stumpage values currently prevent accurate economic analyses of blackwood management in New Zealand.

Conclusion

Options in selecting correct management practices for blackwood in New Zealand are becoming clearer. Analysis of pruning data has narrowed options on form pruning and green crown removal.

In a form pruning trial, the best form improvements resulted when the July biennial 20 mm gauge treatment was applied, although the November annual 30 mm gauge treatment was also successful, and the latter had fewer branches to remove at clearwood pruning.

Results from a green crown removal trial suggest that leaving 3 m of green crown is a reasonable recommendation that balances depression in growth rate with clearwood formation.

In a regime trial series across five sites, data analysis at age 11 yr showed that when thinning was delayed, a significant increase in Mean Top Height compared to thinning to waste at an early age (6 yr) was detected, but no significant diameter response was measured amongst a range of final crop stockings at this age.

More Permanent Sample Plot growth data from older stands are required for growth model validation, but current data and unvalidated growth model predictions indicate that low final crop stockings may be required to produce large logs within an economically acceptable time frame.

Blackwood requires intensive management regardless of the growing system, and intensive silviculture to ensure that trees of good form are obtained.

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7

The Current Experience and New Options with Nurse Crops

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The current experience in Tasmania

The two main approaches to growing blackwood in plantations in Tasmania have been:

- Pure blackwood stands; and
- Blackwood mixed with a nurse crop species.

The nurse crop species most commonly used are *Eucalyptus globulus*, *E. nitens* and *Pinus radiata*, although other species such as *Pommaderis* and *Melaleuca* have been used in some experimental and farm forestry plantings. In general the objective of using a nurse crop species is to provide the blackwood with shelter from frost and cold winds, and to improve form by providing sidelight suppression.

Pure blackwood plantings have the advantage that there is no nurse crop to out-compete the blackwood. This can be a serious problem in mixed plantings. However blackwood has very poor apical dominance, and tends to have very poor form when grown in pure stands. This means that intensive management is generally required to improve form and encourage apical dominance. In addition the young trees are also susceptible to frost and cold damage because they have no early protection.

Forestry Tasmania has concluded that pure blackwood stands are not appropriate for large commercial plantations because of the requirement for high management inputs such as the need for frequent form pruning. Nurse crop systems, if properly managed, are considered to be a better option.

The nurse crop systems trialed by Forestry Tasmania include row-for-row blackwood and *E. nitens* or *E. globulus* (2.5 m between rows), row-for-row blackwood and *P. radiata* (2.5 m between rows) and 2 rows of *P. radiata* to one row of blackwood, with the *P. radiata* being managed for sawlog production (5 m between each *P. radiata* row, and 2.5 m between blackwood and *P. radiata* rows). The row-for row

systems have the advantages of providing some protection to the blackwoods in the longer term, although, at the spacings at which they are grown, they do not provide much early protection. These systems also probably improve stem form. However in our experience form pruning is still required because there is little nursing of the blackwood in the early years because of the between-row spacing. Another potential disadvantage of these systems is that it is very easy for the nurse crop to out-compete the blackwood if the nurse crop is not removed at the right time. *E. nitens*, *E. globulus* and *P. radiata* all have the potential for much faster growth rates than blackwood, which exacerbates this problem. In many cases there is only a very short window where effective ‘nursing’ occurs.

Some blackwood plantations have been established with a view to producing sawlogs from the *P. radiata* nurse crop. This has also been done experimentally with eucalypt nurse crops. This ‘commercial’ system has the advantages of providing income from the nurse crop, and providing longer-term shelter and sidelight suppression for the blackwood from the retained sawlog trees. However it has the same problems associated with mismanagement of the nurse crop, and probably means planting less blackwood per hectare than in a row-for-row system.

No nurse crop system that has been trialed provides much shelter or sidelight suppression to the blackwood during early growth, meaning that form pruning is still required (although generally less intensively than is required for pure blackwood plantations). A major problem in management relates to the inappropriate timing of nurse crop removal, and potential problems such as blackwood suppression and wind damage following nurse crop removal. There has been relatively little research investigating nurse crop management issues such as timing of removal, progressive versus total removal or alternative species/layouts.

New options

Systems

A physiological approach to the development of new silvicultural systems for blackwood forms the basis of a Rural Industries Research and Development Corporation - Joint Venture Agroforestry Programme – (RIRDC-JVAP) project which is now in its second year. These new systems explore alternative arrangements of blackwood with the nurse crop, the objectives being:

- To advance the start of effective sidelight suppression; and
- To be better able to manage sidelight suppression.

There are three treatments including a ‘conventional’ system similar to those just described (Fig. 1). Two treatments use one or other of two nurse crops, the third treatment one or other of three nurse crops. The stand density at planting of the blackwood allows some thinning to final stocking. The plantation was established in October 1999.

Conventional system. This is a one-row blackwood, one-row nurse-crop system. The nurse crop is *E. nitens* or *P. radiata*. Spacings are 4 m between, and 2.5 m within rows. The limitations of this system are expected to be as described above. Blackwood stand density at planting is 500 stems ha⁻¹.

5-row nurse system. This system retains the use of *E. nitens* and *P. radiata* as the nurse crop but there are five rows of nurse crop between the blackwood rows. The innermost nurse-crop row is just 2 m from the blackwood row so that it provides earlier sidelight suppression than in the conventional system. The inner nurse-crop rows will be removed progressively (most likely to waste unless there is a market for Christmas trees!). The time of removal in principle coincides with the point at which the nurse crop starts to suppress blackwood growth. The middle nurse crop row is retained and managed, through pruning, for solid wood. The final distance of the nurse crop from the blackwood is increased to 6 m compared to 4 m in the conventional system. Blackwood stand density at planting is 555 stems ha⁻¹.

Sue Jennings system. This is a 1 m grid and based on an exploratory planting made by Sue Jennings in 1997 on her private property just outside Smithton. Each blackwood is surrounded by two rows of nurse-crop trees. The nurse crop is either *Melaleuca ericifolia*, *Pomaderris apetala* or *Phebalium squameum*. This system is designed to mimic the conditions imposed on the blackwood in native forest systems. The best form

in the blackwood is anticipated from this system, but this will depend on the growth rate of the nurse-crop species relative to that of the blackwood. It is not clear at present whether the nurse crops can yield any economic return. Unreplicated blocks were planted with the three nurse crops only. The blackwood was planted in October 2000, one year later. This was to test whether there might be some advantage in developing a light well over 12-month period before planting the blackwood. Blackwood stand density at planting is 1111 stems ha⁻¹.

Other treatments. In addition to the above, two other treatments were established. Each contain blackwood only planted at 4 m between and 2.5 m within rows. The two treatments are:

- *Control.* This treatment has received no weed control.
- *Artificial sidelight suppression.* This treatment is designed to test the effects of known levels of sidelight suppression on form. In October 2000, shade was imposed by 80% shade cloth placed on each side of the blackwood rows and at 0.5 m from the blackwood. The height of the shade cloth is either tree height, 50% of tree height, or 150% of tree height.

Management

All treatments except the control were manually weeded in the first year. There has been no chemical weed control. All trees were fertilised with triple superphosphate at a rate of 29 g tree⁻¹ (occupying 1 m²). This is equivalent to 60 kg ha⁻¹ of elemental phosphorus.

Growth

Establishment of the plantation was very slow in the first year because of exceptionally low rainfall during the growing season. At age 12 months, height growth of blackwood across treatments was between 53 and 74 cm (average 65 cm). For the nurse crops, *E. nitens* was 80 cm, *P. radiata* 60 cm, *M. ericifolia* 47 cm, *P. apetala* 43 cm and *P. squameum* 18 cm.

It is too soon to make conclusions about the relative performance of the different treatments. The poor performance of *P. squameum* may be related to lack of vigour in the cuttings used.

Acknowledgment

We thank Jane Medhurst and Dale Worledge for providing the growth data from the Esperance experiment.

Nurse Crop Systems

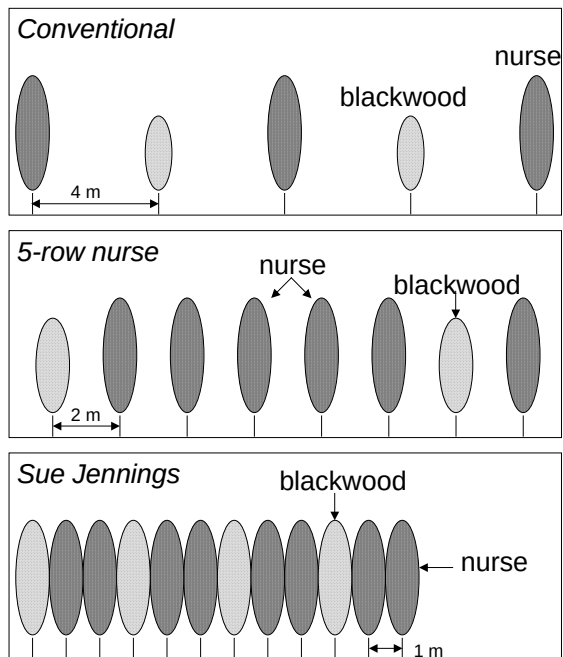


Figure 1. The relativities of the nurse crop and blackwood in the three systems used in the Esperance experiment.

8

***Acacia melanoxylon* Provenance Trials in Victoria - Growth and Form Evaluation at Age Six Years**

Des Stackpole

Department of Natural Resources and Environment, Victoria

Introduction

Vernacular accounts have it that *Acacia melanoxylon* is a tree with weak apical dominance, which results in a tendency for the leader to fork. Hence, the species is thought to usually require silvicultural management to enhance growth of straight leaders. However, there have been no published accounts of investigations into the expression, by provenance, of form and growth rates. To test this, two trials were planted in 1993 in north east Victoria. The objective was to test whether variation in stem form or growth rate exists in *A. melanoxylon*, which might then guide selection of provenances, or at least direct future investigations.

Method

Victorian sites chosen were thought likely to represent land bases that might have potential for expanded planting. Tallangatta was at 210 m asl, on fluvial sediments on the Mitta Mitta river floodplain, near Eskdale. Annual rainfall is 926 mm. Euroa is at 540 m asl, on sloping acid granitic soils at Kelvin View, near Strathbogie. Annual rainfall is 954 mm. The climate of both sites is Mediterranean, with Tallangatta averaging three degrees warmer July and January. Twenty-five seedlots from CSIRO and DNRE collections (details, Appendix 1) were planted in complete random blocks (6 at Euroa, 5 at Tallangatta); rows alternated with complete rows of *E. globulus*, the latter intended to behave as cover crops. Spacing of trees was 2 x 3 m, which provided a stocking of 833 sph for *A. melanoxylon* and 833 sph for *E. globulus*. All seedlots were planted in a further area as single-tree plots in nine replicates at Euroa, without cover crops. *A. melanoxylon* stocking here was 1667 sph. This area enabled comparison of form, height and growth rate between the two planting layouts at Euroa. The trials were measured for diameter and form at six years of age. Form was evaluated by subjective assessment of the stem into one of (i) straight single stem axis, (ii) straight axis but with large branches or forks which will require pruning if a single bole is to be achieved, (iii) no prospect of a single bole regardless of pruning, and (iv) missing. Diameters were used to calculate plot basal area. Plot basal area and average height were

used to calculate a volume index (VI) using a conic formula. Basal area and form were analysed for significant differences within sites. Seedlots common to both sites were then analysed using a pooled residual mean square term to explore site by seedlot interaction⁵, and to identify which if any seedlots grew straighter or faster at both sites.

Overall growth rate

Growth, as expressed by total basal area and VI of *A. melanoxylon* at age 6 was slow, and similar at both sites (Table 1). Basal area and VI were not substantially affected by cover crops (about double the rate, at twice the stocking, Table 1, see arrows) to age six although height growth under covers was 1 m or about 15% greater.

Overall form

Over both sites, under covers, 6.5% of trees had a single trunk, 22% of trees could be made so by form pruning, and around half of trees planted produced stems with unusable boles (Table 2). Cover crops improved the incidence of single, straight trunks from 3% to 7% where the comparison could be made at Euroa.

⁵ Williams, E. and Matheson, C. (1994) *Experimental Design and Analysis for Use in Tree Improvement*. CSIRO, Canberra. 174 pp.

Table 1. Height, basal area, and volume [index] of *Acacia melanoxylon* and *Eucalyptus globulus* cover crop at Euroa and Tallangatta at age six years. Compare the bold figures to see the effect of covers at Euroa.

Site and treatment	Species	Seedlot	Mean height (m)	Basal area (m ² ha ⁻¹)	Volume index
Euroa (covers)	AMEL	Av. all	5.8	2.7	5.2
	GLOBU		12.0	10.4	41.6
Euroa (no covers)	AMEL	Av. all	4.8	6.8	10.9
Tallangatta (covers)	AMEL	Av. all	6.3	2.5	5.2
	GLOBU		Not estimated		

Table 2. Proportion of stems in log potential classes at Euroa and Tallangatta (%)

Site and treatment	Straight	Form-prune	Unusable	Missing
Euroa (covers)	7	26	49	18
Euroa (no covers)	3	21	63	12
Tallangatta (covers)	6	18	50	27

Provenance differences within site

Significant differences for both basal area growth and form were found between provenances within each site (Table 3). Note that at the Euroa site, two of the three provenances from Queensland displayed very low survival (Table 4), and the three had the lowest basal area overall. This was not the case at Tallangatta.

Site interaction on provenance performance

Both sites produced very similar growth rates of *A. melanoxylon*. There was no set of consistently superior provenances for basal area growth at both sites. Provenance expression of form at both sites was significant (Table 5).

Table 3. Significance (probability) of provenance differences within each site

Attribute	Euroa	Tallangatta
Basal area	<0.001	0.046
Form	<0.001	<0.001

Table 4. Survival, basal area and form of *Acacia melanoxylon* provenances at age six years at Euroa. Seedlots in bold ranked in the best ten for both basal area and form.

Seedlot No.	Ranking by BA		Ranking by form	
	Survival (%)	Basal area	Seedlot No.	Form
15863	95	5.02	16526	1.98
16513	97	4.52	17190	2.04
15614	100	3.98	20002	2.29
18021	92	3.82	17264	2.33
18084	100	3.75	18084	2.39
17229	97	3.50	17229	2.40
16526	97	3.46	17194	2.43
15535	100	3.35	18021	2.50
20002	89	3.16	15614	2.64
17958	97	3.05	15863	2.68
17075	97	2.94	15535	2.72
17190	83	2.93	17230	2.75
17194	94	2.72	16513	2.78
17230	92	2.46	16272	2.83
16272	92	2.37	20001	2.93
20001	67	2.13	20003	3.02
18309	97	2.08	20004	3.12
20004	94	1.98	18309	3.16
16725	56	1.82	17263	3.33
20003	75	1.79	17075	3.34
17264 Qld	86	1.55	17958	3.39
17263 Qld	39	1.07	16725	3.70
15821 ^a Qld	36	0.35	1582 ^a	3.72
Mean	85.7	2.71	Mean	2.83
LSD		1.03	LSD	0.49
F probability		<.001		<.001
RMS		0.807		0.187
replicates		6		6

^a At Euroa only

Table 5. Significance (p) of provenance x site interactions

Basal area	Form	Observation
<0.001	<0.001	Strong provenance by site interaction
0.170	0.007	No provenances outstanding for basal area at both sites, consistent form trend among provenances at both sites.
0.224	0.413	Both sites overall similar effect on <i>A. melanoxylon</i> growth

Selection of provenances

Selection of superior provenances from this process involves ranking of factors. This can be done using various levels of factors for inclusion.

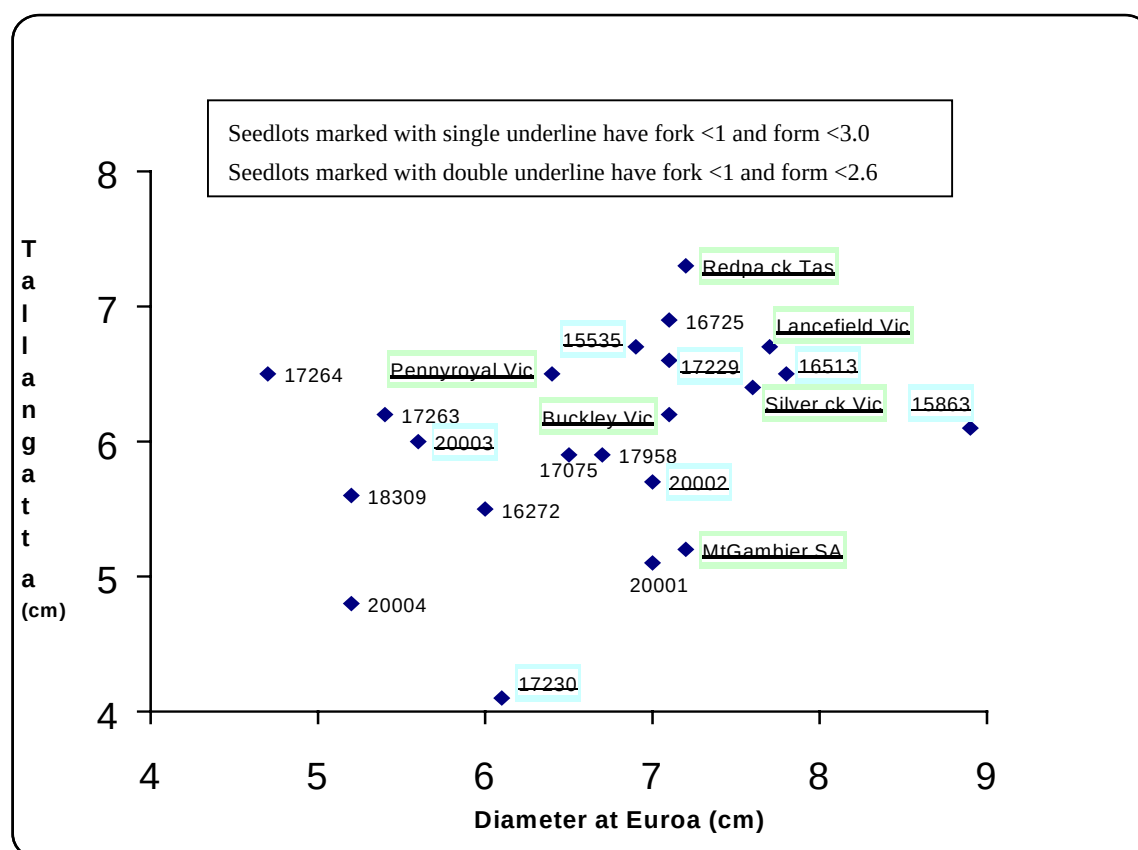
Figure 1 plots mean stem diameter for both sites, with two levels of stem quality (degree of forking and stem form) overlaid. This is an arbitrary basis for assessing provenances, and should be treated with some caution.

However, such a process enables identification of promising provenances for further attention.

Conclusions

A. melanoxylon grew very slowly overall on these sites, which suggests that the sites are not optimum for growth. Hence, closer attention to finding sites with shelter from wind, deep soils, and suitable moisture content might be required. Queensland provenances are not promising on the colder of the two sites.

While form varied between provenances in a consistent pattern across two sites, even the best-formed provenance (score 1.98, seedlot 15863, Table 4) would still require form pruning to achieve a satisfactory stocking of crop trees under typical establishment stockings. Some provenances were identified which had superior growth rates and above-average form, which might provide a start for further investigations.



Appendix 1. *Acacia melanoxylon* provenances tested

State	Seedlot number ¹	No. parent trees	Provenance	Latitude (° ')	Longitude (° ')	Altitude (m asl)
Tasmania	15535	12	Burnie	41 16	145 45	470
Tasmania	20003	5	Arthur River	41 01	145 01	25
Tasmania	15863	10	Lileah	40 57	145 10	250
Tasmania	18084	15	Redpa	40 55	144 46	50
SA	16526	10	Mt Gambier	37 57	141 56	40
Victoria	17190	12	Buckleys Swamp	37 57	141 59	140
Victoria	20004	5	Carlisle River	38 35	143 22	80
Victoria	17194	4	Pennyroyal	38 26	143 53	200
Victoria	17075	10	Diggers Rest	37 37	144 44	180
Victoria	18021	15	Lancefield	37 14	144 46	500
Victoria	17230	15	Yan Yean	37 34	145 08	214
Victoria	17229	10	Highlands	37 04	145 24	640
Victoria	20005	na	Yackandandah	36 20	145 49	300
Victoria	20001	8	Warrenbayne Ck	36 44	145 52	300
Victoria	20002	5	Toorour	36 51	145 53	600
Victoria	15614	na	Silver Ck	38 22	146 15	240
Victoria	16513	10	Welshpool	38 34	146 22	250
Victoria	20006	na	Sandy Ck	36 22	147 08	350
Victoria	16272	10	Bonang	37 19	148 42	300
NSW	18309	30	Tallaganda SF	35 26	149 31	900
NSW	17958	4	Sassafras	35 06	150 16	740
NSW	16725	8	Stroud	32 11	151 51	150
Queensland	17264	2	Springbrook	28 14	153 17	750
Queensland	17263	9	Mt Mee	27 06	152 44	500
Queensland	15821	10	Ravenshoe	17 35	145 32	1000

¹Seedlots commencing with '2' were collected by the Department of Natural Resources and Environment, Victoria, Australia; all others were supplied by CSIRO Australian Tree Seed Centre

9

Form Pruning – A New Zealand Experience

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Introduction

I planted my first blackwoods in a small valley in the far north of New Zealand in 1980. They were planted in groups in a grid, which included radiata pine as a nurse and received annual form pruning from the first summer. Because of conflicting interests (fishing), not all trees were pruned. After two years it became apparent that-

- The pruned trees were strikingly better than untreated trees; and
- The pines were too small to influence the blackwoods.

In 1982 I planted blackwoods in groups at final spacing without a nurse, and carried out annual form pruning. In subsequent plantings they were mixed with pines, and eucalypts, and in light wells cut in native scrub.

The open-grown system, combining group planting and annual form pruning without a nurse, was the easiest to manage and produced the best trees, and has been used in subsequent planting.

Problems with nurse crops

1. The cost of establishment and management of the nurse;
2. When the nurse was planted one to two years in advance, the blackwoods were planted in long grass, losing the benefit of site preparation;
3. Regular visits were needed to trim competing leaders in the blackwoods, and aggressive branches in the nurse;
4. The duration of optimal shading was limited, in radiata pine from year 4 – 6;
5. Delay in nurse disposal had adverse effects – some blackwoods were damaged during felling, and were prone to windthrow in the next year, and crown distortion subsequently;
6. Retention of a nurse (a temptation with eucalypts) caused significant growth reduction compared with open-grown trees; and
7. After felling the nurse, access was difficult for further silvicultural work.

Preconditions

A good site

To produce good form and growth, blackwoods have strict site requirements. In New Zealand the sites which combine good soils, shelter and summer moisture are found in lower valley slopes and sheltered gullies. Common mistakes are to plant on dry, exposed sites ('blackwoods grow anywhere') where growth is slow, malformation severe and psyllid damage common; or in stagnant bogs ('blackwoods grow in swamps').

A kick start

Blackwoods share with other tree species the 'compound interest effect' in which the benefit of fast early growth compounds through the rotation.

In addition it allows advantage to be taken of the juvenile growth phase which sustained includes extension growth and good branch architecture.

- Weed control for the first two summers;
- Correction of nutrient deficiencies (some of our soils are phosphate deficient);
- Psyllid control for the first two to three summers; and
- Tree shelters – on our site KBC shelters used to control hares added 25% to extension growth.

Malformation

In open-grown blackwoods malformation is a product of the combined effects of growth periodicity and shoot tip abortion.

Periodicity

In New Zealand, blackwoods show a common growth pattern, with two distinct periods of summer growth. If we apply Borchert's (1991) model, which links periodicity to sequential adjustments in the root – shoot ratio, a suggested sequence in the annual growth cycle is as follows:

1. An initial phase of root expansion in winter;
2. Shoot growth, starting in early spring in response to rising temperature. The expanding shoots are powerful nutrient sinks, and a progressive imbalance develops between root and shoot growth. Triggered by a period of dry weather, shoot growth stops about mid-December;
3. A period of apparent quiescence in early summer, in which the imbalance is corrected by shedding of phyllodes from lower and shaded branches, and probably a phase of root expansion; and
4. A second phase of shoot expansion, after 6 – 8 weeks, often triggered by a wet period. Shoot growth continues until about April.

The growth pattern is influenced by two factors –

1. Maturation

Blackwoods containing juvenile foliage lack periodicity, and can grow without interruption during the summer, allowing up to 3 m extension growth in the first year. Juvenile growth is associated with –

- Shelter and moisture;
- Provenance; and
- Adjacent vegetation. Growth responses to adjacent vegetation were studied at Pirongia (Bathgate and Brown 1966). Trees were tallest at 1 m from surrounding vegetation and the effect was lost at 3 m. The taller trees showed a delayed conversion of juvenile foliage to phyllodes and had longer growth segments and better branch architecture. Delayed phase change is probably one of the mechanisms of the nurse crop effect.

2. Psyllids

In New Zealand, acacia psyllids commonly attack the shoot tips near the end of each growth period, in December and again in autumn. The effect is to shorten the periods of growth. When psyllids were controlled by spraying, the terminal shoots gained 40% in extension growth compared to controls – both groups, however, showed growth periodicity and malformation.

Shoot tip abortion

Periods of growth in blackwoods are terminated by abortion of the shoot tip – this occurs by accident (insects) or design (completion of periodic growth).

The leader is replaced in a contest between terminal shoots. The outcome varies: in a light well, a single leader is likely to prevail. When open-grown, double or multiple leaders are more common. The replacement leader is defined by its branch collar, and the resultant

collar scar, which encircles the stem, persists for two to three years.

Segmental growth

A blackwood stem develops as a sequence of growth segments in which branches appear in orderly succession (Brown 1997). The segments are separated by zones of disturbance, in which the two elements of malformation appear : multiple leaders and stem kinks.

Stem kinks

These occur at the segmental junction, the point of origin of the new leader. Kinks can be prevented by early removal of the competing leader – the pruning defect occludes quickly, and stem realignment is rapid.

Form pruning

Attention should be given to both stem and crown.

Stem pruning involves two steps – leader training and clearwood pruning.

Initial pruning is selective, and is confined to the competing leaders at the segmental junction. The replacement leader is selected, and competing leaders are removed – these can be recognised either visually or by measurement.

- Measurement. A simple method has been developed by Forest Research (Nicholas and Gifford 1995). Branches are measured annually with a 3 cm caliper, and branches which do not fit are removed (this includes competing leaders and larger stem branches).
- Visual inspection. This will be described.

Leader training

This is best done in late spring, when the shoots are growing vigorously. There are two steps:

1. The best leading shoot is selected, traced to its point of origin (Fig. 1), and the competing shoot is removed (Fig. 2); and
2. Any vigorous branches that remain are shortened to half length.

The pruning defects occlude quickly and the stem realigns.

This process can be repeated during the second growth flush in late summer.

With secateurs (long handled versions are available) the job takes just a few seconds.

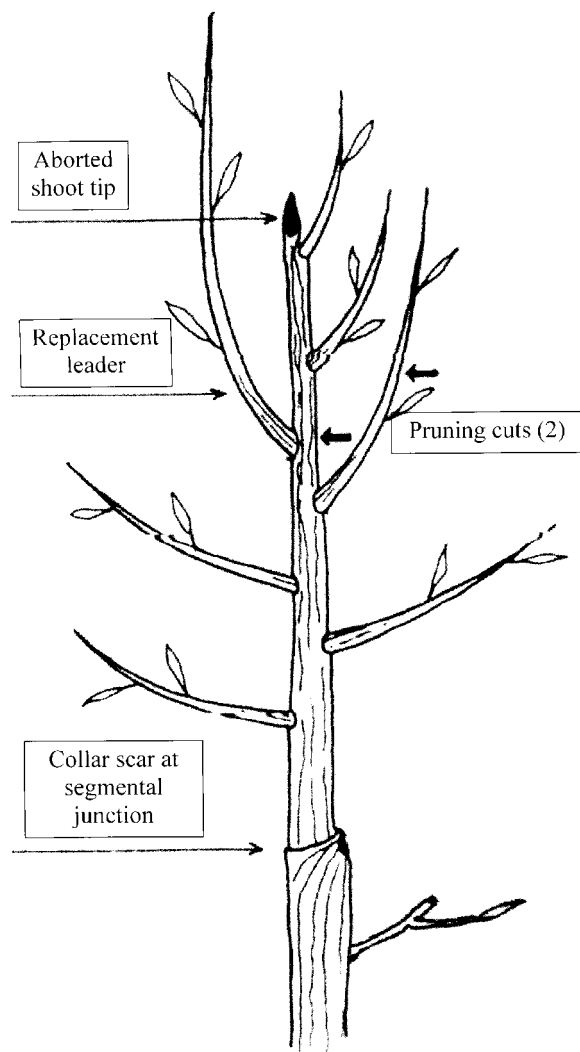


Figure 1. Blackwood shoot before leader training

Above 4 m it is difficult to prune with accuracy, and it is easier to shorten competing leaders, and tidy them up a year or so later.

Leader training is repeated annually until the tree reaches 5 – 6 m (usually by four years). We have found that there is no effect on height, and a modest loss in diameter compared to unpruned trees.

Clearwood pruning

I usually start branch reduction at year four, removing the largest branches wherever they are located on the stem, and remove up to about 40% of the foliage.

This is repeated annually until the bole is cleared to 5 - 6 m (usually by year eight).

Thinning and Spacing

I plant in groups of 3 – 4 trees, 2 m within the group, and 7 – 8 m between groups.

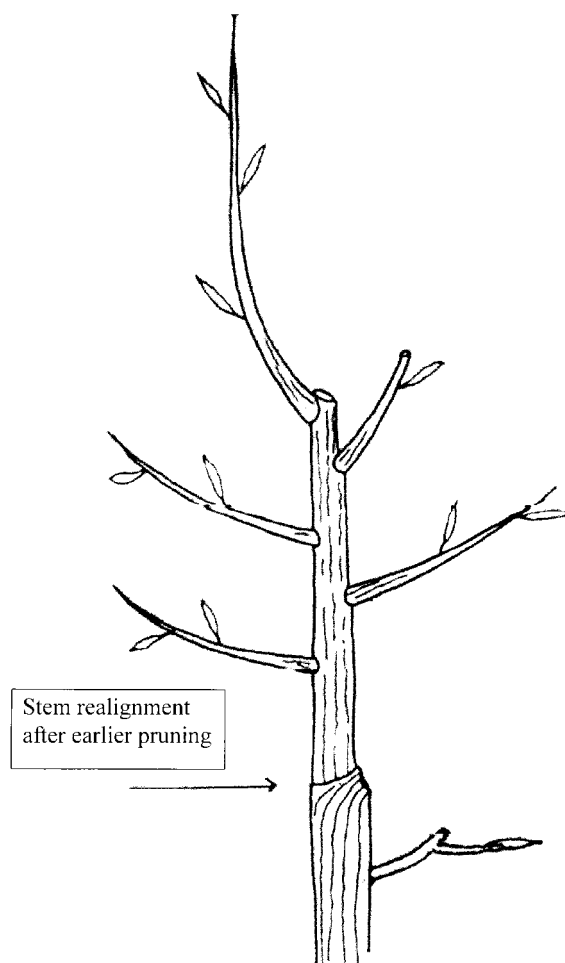


Figure 2. Blackwood shoot after training by segmental pruning

At year five the two best trees in each group are selected and the rest removed; the two are reduced to the final tree by year eight.

All silvicultural work is complete by eight years (add a year or two on tougher sites).

Crown management

This is a neglected aspect of blackwood management. I have found three common problems in crown structure-

1. Small high crown

Lateral shading is useful during establishment of the 6 m stem, but has adverse effects on crown structure. When forced to compete for light, the live crown retreats with disconcerting speed; the outcome is a small high crown, perched on long vertical branches.

This has the following effects:

- Slow diameter growth;
- Instability and branch splitting; and
- Impaired disease resistance

The problem can be prevented by early thinning, which allows the crowns to expand without interference.

2. Asymmetric crown

Blackwoods are crown-shy, and two crowns in close proximity will interact. The effect is asymmetric crown development and associated stem curvature, which will probably create tension wood problems during milling.

Spacing between final crop trees should therefore be fairly even.

3. Unstable crown

The problem is breakage at a major fork at the base of the crown. It is associated with delayed thinning, which produces vertical branches with a long lever arm.

It is prevented by shortening competing leaders in the crown base.

The temptation to prune up to a fork should be resisted. Retention of a few live branches just below a fork will reduce the risk and severity of stem breakage.

Tools

By using long-handled tools, all pruning can be done from the ground. Useful tools are:

1. Extended secateurs (e.g. ARS pruners). Designed for horticultural use, these allow leader training on small branches.
2. Pole pruners (e.g. Wolff, Sandvik). More robust, with a cord, and secateur action.
3. Extended chain saw (Stihl HT75). This allows pruning up to 5 m. An excellent tool for trees over five years.

The target tree

- Evenly spaced at 7 – 8 m.
- Stem – straight and pruned to 5 – 6 m, with 2.5 – 3 cm annual diameter increment.
- Crown – live at the base, symmetrical and stable.

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10

Vegetative Propagation of Blackwood from Root Cuttings

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Vegetative propagation of *Acacia melanoxylon* using root cuttings was studied to determine the best combination of treatments. Ten trees from each of three distinct provenances (Otways, East Gippsland and Canberra) were selected to provide cuttings, and different media, hormones and times of year were tested. Provenance, potting media, hormone and season significantly affected the number of viable shoots produced. Mature blackwood can be vegetatively propagated successfully, producing morphologically juvenile plants suitable for plantation establishment.



Figure 1. Suckers from exposed roots of blackwood in a natural environment

Introduction

The option of vegetative propagation to produce planting stock, or in a breeding program, is valuable. Although mature acacias may be difficult to propagate by stem cuttings, some species, including blackwood, produce suckers from roots in their natural environment (Fig. 1), and can be propagated by root cuttings (Fig. 2).

This study was undertaken to assess the importance of variables likely to affect the success of vegetative propagation of blackwood using root cuttings from mature trees, and thus to suggest an optimum procedure.

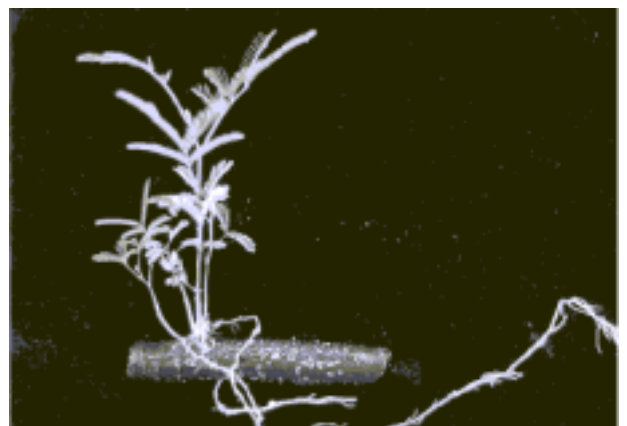


Figure 2. A blackwood root cutting showing the juvenile shoots and independent roots

Method

The treatments applied are listed in Table 1.

Table 1. Treatments tested in factorial combination

Provenance	Pre-treatments	Media types	Season of collection
Bambra (Otways)	None	Coarse sand	Autumn (April 1996)
Wingam (East Gippsland)	Indole-3 butyric acid (IBA) (150 mg L ⁻¹)	Burnley Mix-	Winter (July 1996)
Namadgi National Park (Canberra)	Gibberelic acid (GA) (50 mg L ⁻¹)	1 part peat moss	Spring (September 1996)
	6-Benzylamino purine (BAP) (75 mg L ⁻¹)	9 part pine bark	Summer (February 1997)
	Sucrose (5 g L ⁻¹)	375 g : 500 L dolomite	
		750 g : 500 L saturaid	
		Perlite and vermiculite (50:50)	

Results

Salient results are portrayed in the following tables and figures.

What was significant?

Each of the main factors tested had significant effects (Table 2). Because of interactions involving provenance % season (Fig. 6) the seasons were analysed separately (Table 3). Most other interactions were negligible (Table 3 and Figs 5, 7 and 8)

Table 2. Analysis of variance of number of shoots produced per 10 cuttings (square root transform)

Source of variation	DF	Mean square	F Value	Probability
MIX	2	12.2600	9.07	0.0005
HORM	4	35.2509	26.07	0.0001
PROV	2	35.8879	26.54	0.0001
SEASON	3	54.5806	40.36	0.0001

Effect of season of collection of cuttings

The total number of shoots produced from the successive harvests in each season varied substantially (Table 2; Figs 3, 5 and 6). Ten weeks after setting the cuttings, production of shoots effectively finished (illustrated by results for autumn, Fig. 4), and they can be harvested regardless of provenance. (The pattern was similar in the other three seasons). These results may have real implications for collection time and suggest collection should be undertaken in autumn. However, they may also indicate that the first collection from a mature tree gives the best results; other trials will be needed to determine which of these possibilities is correct.

Table 3. Analysis of variance of number of shoots produced per ten cuttings (square root transform)

Season	Source of variation	DF	Mean square	F value	Probability
Autumn	MIX	2	8.1157	3.52	0.054
	HORM	4	16.6051	7.21	0.002
	PROV	2	9.8854	4.29	0.032
	MIX x H	8	3.5494	1.54	0.220
	PRO x M	4	1.6661	0.72	0.589
	PRO x H	8	2.0456	0.89	0.548
	Residual	16	2.3041		
Winter	MIX	2	6.2994	3.49	0.0551
	HORM	4	12.0585	6.69	0.0023
	PROV	2	26.6828	14.80	0.002
	MIX x H	8	1.0444	0.58	0.7805
	PRO x M	4	0.3910	0.22	0.9259
	PRO x H	8	5.0752	2.81	0.0372
	Residual	16	1.830569		
Spring	MIX	2	0.5379	0.29	0.7535
	HORM	4	8.4259	4.51	0.0125
	PROV	2	9.0202	4.83	0.0228
	MIX x H	8	0.7590	0.41	0.9005
	PRO x M	4	2.2729	1.22	0.3422
	PRO x H	8	3.2511	1.74	0.1642
	Residual	16	1.867		
Summer	MIX	2	5.1417	2.38	0.1243
	HORM	4	3.4971	1.62	0.2178
	PROV	2	2.1904	1.01	0.3847
	MIX x H	8	1.3690	0.63	0.7385
	PRO x M	4	3.0087	1.39	0.2807
	PRO x H	8	2.3236	1.08	0.4260
	Residual	16	2.1590		

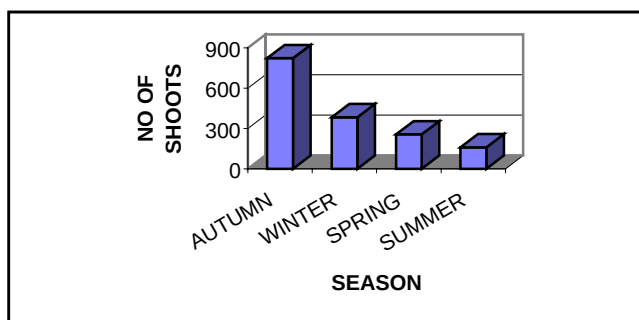


Figure 3. Total shoot production from cuttings taken in each season

Of the hormone pre-treatments, IBA produced the poorest result; the control, sucrose and GA were not appreciably different, and BAP was intermediate (Table 5; Fig. 7).

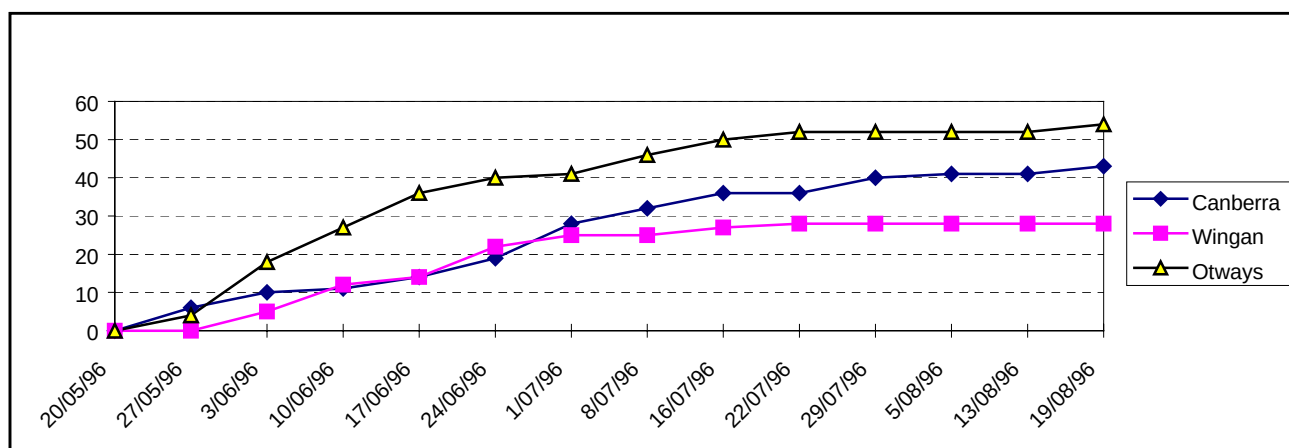


Figure 4. Time course of appearance of shoots from cuttings in autumn

Table 5. Shoot production (rooted and unrooted) for each hormone pre-treatment and provenance for the four seasons

Season	Provenance	Pre-treatment					Total
		None	GA	IBA	BAP	SUC	
Autumn	WIN	58	68	7	20	47	200
	CAN	64	75	4	26	71	240
	OTW	69	92	16	86	119	382
	Total	191	235	27	132	237	822
Winter	WIN	11	3	0	7	22	43
	CAN	13	28	7	4	6	58
	OTW	111	68	0	18	86	283
	Total	135	99	7	29	114	384
Spring	WIN	9	2	0	12	19	42
	CAN	6	28	0	13	3	50
	OTW	70	40	0	24	30	164
	Total	85	70	0	49	52	256
Summer	WIN	14	0	0	0	24	38
	CAN	21	36	0	6	4	67
	OTW	5	21	10	5	13	54
	Total	40	57	10	11	41	159

Which potting mix?

Burnley mix gave the best overall result (Fig. 5). The perlite and vermiculite medium appeared to be too well-drained, allowing the cuttings to dry out. On the other hand, the coarse sand medium did not drain well and kept the root sections too moist, causing a few of them to rot.

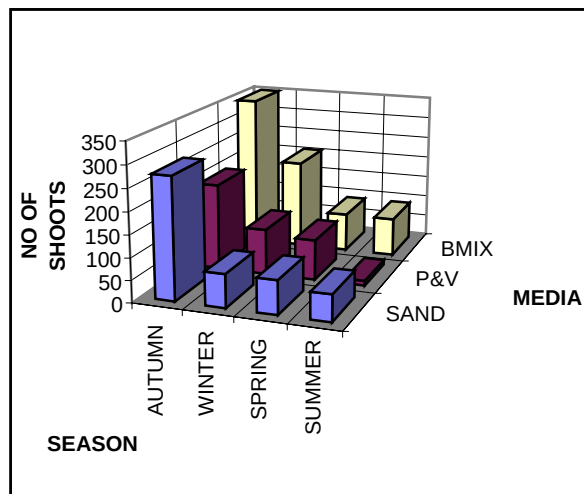


Figure 5. The effect of interaction of season of collection of cuttings and media on shoot production

Provenance by season

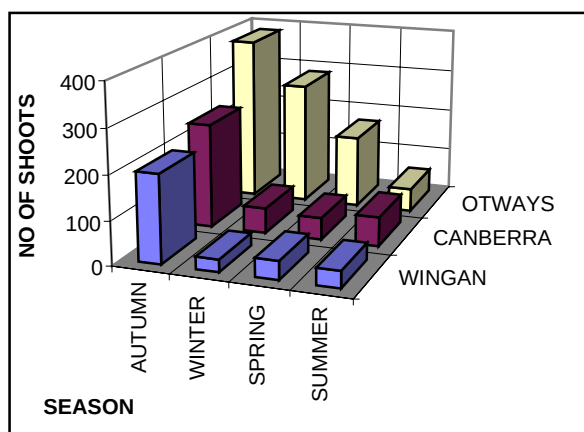


Figure 6. The effect of interaction of season of collection of cuttings and provenance of ortet on shoot production. The seasonal pattern for the Otways is distinctly different to that found in the other two provenances, giving rise to the most important first-order interaction found.

Provenance by pre-treatment

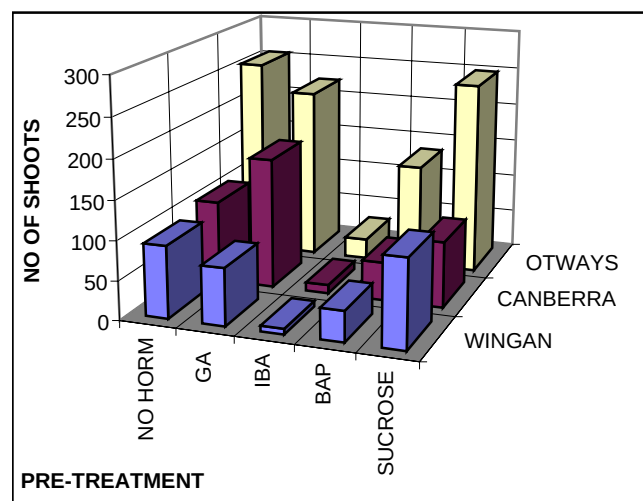


Figure 7. The effect of interaction of hormone pre-treatment and provenance of ortet on shoot production

Provenance by potting mix

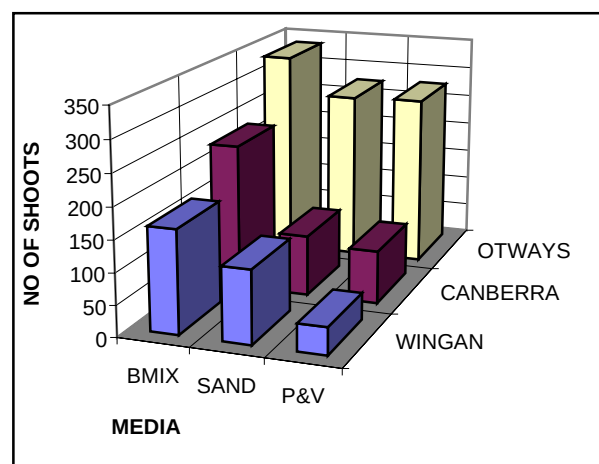


Figure 8. The effect of interaction of provenance of ortet and media on shoot production

Variation in shoot production between ortets

Within all provenances, there was large variation between ortets in shoot production (Table 5).

Table 5. Total shoot production by individual ortets

Ortet No.	Otway	Canberra	Wingan
1	45	78	1
2	22	15	1
3	4	29	8
4	153	13	80
5	113	88	106
6	101	3	50
7	105	2	4
8	255	140	49
9	15	10	9
10	73	37	0
Total	886	415	308

Adventitious root formation

Adventitious roots were not present on all the new shoots. The total number of shoots produced by cuttings for each combination of provenance of ortet and season of collection is shown in Table 6, together with the number of those shoots that produced adventitious roots ('trees') (Fig. 2).

Table 6. Total yield of shoots, and those with adventitious roots ('trees'), in each provenance and season of collection

Provenance of ortet	Season of collection of cuttings								Total		
	Autumn		Winter		Spring		Summer				
	Shoots	Trees	Shoots	Trees	Shoots	Trees	Shoots	Trees	Shoots	Trees	% Trees
Otway	372	119	287	80	164	46	54	11	877	258	29
Canberra	187	49	58	20	50	15	67	15	415	119	30
Wingan	173	34	43	30	42	4	38	9	296	58	20

Stem cutting trial

A method of propagating the shoots that did not produce their own root systems was investigated. This involved severing the shoots from the original root cuttings, and treating 100 of the resulting shoot cuttings with IBA (8000 ppm); another keeping another 100 with no treatment as a control. The cuttings were then placed in Burnley mix in a glasshouse with bottom heat and misting for twelve weeks. Over 80% of the IBA-treated cuttings produced their own root systems, but only 36% of the control did so.

Conclusion

Although some individual trees may not strike easily, root cuttings are an effective means of propagating mature blackwoods. Even where the root cuttings do not form independent roots, the technique can be used to 'juvenilise' the genetic material and allow stem cutting techniques to be employed to generate planting material, or to mass-produce genotypes of interest.

11

The Clearwood Pruning of *Acacia melanoxylon*, Associated Decay and Discoloration

Stuart Swanson

Private Forests Tasmania

Introduction

I investigated the internal log quality of *Acacia melanoxylon* (blackwood), following clearwood pruning, in 1998 as part of my final-year university project.

Neil Barr, a well known New Zealand farm forester, considered that blackwood occludes well following pruning (Allen 1988). However, others are adamant that blackwood should not be pruned due to poor occlusion (R. Reid 1997, *pers. comm.*). Unfortunately, very little is known about the response of blackwood to clear-bole pruning. The presence of decay or encased bark can make a piece of sawn timber worthless (Reid 1996). To what extent this occurs, or is likely to occur, within blackwood is largely unknown.

Method

Pruned blackwood was obtained from Bambra Agroforestry Farm, in the Otway Ranges, Victoria. The trees had been planted in a riparian buffer strip in 1987, mostly with *Eucalyptus nitens* as a commercial nurse crop. Nine trees 11 yr old, with pruned heights ranging from 1.7 to 3.9 m, were selected for this study. All were of poor form; average height was 12.2 m and average diameter 21.2 cm. In these trees, a total of 147 branch stubs were exposed, with diameters ranging from 3 mm to 40 mm. The extent of occlusion ranged from that on recently-pruned branch stubs to completely occluded pruning wounds.

To what extent was decay, occluded bark and insect activity associated with clearwood pruning and subsequent occlusion? If present, were these defects confined to the knotty core or were they causing, or likely to cause, degrade of the clearwood? Many of the trees (including crop trees not selected for this study) looked all right from the outside, but what had been occurring on the inside?

The criteria used to assess the extent of occlusion, occluded bark and observable decay associated with each branch stub are given in Table 1..

Table 1. Criteria for assessing the extent of occlusion, occluded bark and visible decay within branch stubs

Factor	Score	Description of 'score'
Extent of occlusion	0	Branch stub fully occluded.
	1	Woundwood ribs grown over the ends of the branch stub, although not yet having met to result in complete occlusion.
	2	Woundwood ribs not yet grown over the ends of the branch stub, but up to the end of the stub.
Extent of occluded bark	3	Woundwood not having developed to any appreciable extent.
	0	No occluded bark within the clearwood zone.
	1	Occluded bark extending no further into the clearwood zone than stub diameter.
Extent of decay	2	Occluded bark extending further into the clearwood zone than stub diameter, although not extending to the outer bark.
	0	No visible decay.
	1	Decay extending no further into the stub than stub diameter.
	2	Decay extending further than stub diameter but not having progressed to the core of the tree.
	3	Decay spread through the branch stub and into the centre of the tree.

Results

Rate of occlusion

The rate of occlusion is influenced by:

- *Branch diameter* - the smaller the branch the faster the occlusion.
- *Stub length* - 'coat hangers' result in slower occlusion.
- *Diameter increment* - faster diameter growth results in faster occlusion.
- *Pruning quality* - damage such as bark tearing, or pruning that leaves a 'coat hanger', can greatly increase the time required for occlusion.

When pruning is performed well, and given the growth rates of these trees at Bambra Agroforestry Farm, blackwood appears to take about one to one-and-a-half years to occlude per 10 mm of branch diameter.

Extent of occlusion

About 70% of the branch stubs exposed during this study had completely occluded by age 11 yr (Table 2). Trees used for this study were not suitable for final crop trees. As a general observation, most crop trees, having been pruned to over 6 m, appeared to have a greater fraction of their branch stubs occluded.

Table 2. The extent of occlusion of pruning wounds

Score	0	1	2	3	Total
No. of stubs	104	13	21	9	147
Fraction of stubs (%)	70.7	8.9	14.3	6.1	100

Position of occlusion

Table 3 indicates the position of occlusion relative to the end of the branch stub. Even occlusion (woundwood ribs meet in the middle of the branch stub) is considered by authors such as Shigo to be one indication of satisfactory pruning.

Table 3. The position at which occlusion closes, or could be expected to do so

Position	M	B	T	Total
No. of stubs	84	37	17	138
Fraction of stubs (%)	60.9	26.8	12.3	100

M Occlusion observed to have occurred within the middle third of the branch stub.

B Occlusion observed to have occurred within the bottom third of the branch stub.

T Occlusion observed to have occurred within the top third of the branch stub.

Extent of observable decay

Table 4 shows the extent of observable decay within exposed branch stubs. Of interest is the fraction of

branch stubs with compartmentalised decay contained within one branch diameter. There is no significant difference with respect to the extent of observable decay between branch stubs that had completely occluded and those that were yet to fully occlude. This indicates that blackwood has the ability to successfully compartmentalise decay prior to complete occlusion.

Table 4. The extent of observable decay within branch stubs

Score	0	1	2	3	Total
No. of stubs	6	107 (76 ¹)	26	8	147
Fraction of stubs (%)	4	73 (71 ¹)	18	5	100

¹Number and percentage of stubs that were completely occluded and assigned a score of 1.

A tree's ability to compartmentalise decay is under moderate to strong genetic control (Shigo 1991). Of the eight branch stubs that were observed to have had decay progress to the centre of the tree, six were from a single tree. This tree had a diameter of 21.2 cm, a height of 11.8 m and a pruned height of 2.4 m. In total, eight branch stubs were exposed from this tree. Diameters of the six branch stubs in which decay had progressed to the centre of the tree ranged from 15 mm to 23 mm, and all but two had occluded in the middle of the branch stub. This tree was found to have occluded exceptionally well along the 2.4 m pruned height, with complete occlusion by age 11. Decay had entered through the branch stubs, spread to the centre of the tree and progressed to within 50 cm of the base. Infected heartwood had turned a creamy-white, was relatively soft and about 3 cm wide. Dark lines of phenolics had formed around the outside of this decay. Heartwood outside this core of soft, light-coloured wood was also infected; although presumably at an earlier stage of decay. Heartwood within this zone had turned darker than the adjacent uninfected heartwood. Numerous lines of phenolics were present, with some portions turning a creamy white colour as previously described. It is uncertain whether this decay had progressed outwards from the initial infection within the centre of the tree or progressed down through the tree from pruning positions higher in the bole. If this decay was breaking out from the initial infection, then the clearwood zone had the potential to be degraded by the spread of decay.

Mid-rotation crop tree death has occurred at Bambra Agroforestry Farm and elsewhere, including New Zealand. Internal decay resulting from pruning may cause or contribute to tree decline and death. One dead tree (pruned) was cut open and decay was evident throughout the heartwood and sapwood, and a fungal fruiting body was growing at the base of the tree.

Extent of occluded bark

Table 5 shows the number and fraction of stubs that were found to be associated with occluded bark. Just over half the branch stubs had a small amount of

occluded bark at the end of the branch stub, extending for no more than one branch diameter. Of the ten occurrences where occluded bark extended further than one branch diameter, only one was of concern. In this instance, complete occlusion had failed to take place and a considerable amount of occluded bark extended through the clearwood zone to the outer bark. The other nine had minimal traces of bark beyond one branch diameter and extended for no more than two branch diameters.

Table 5. The extent of occluded bark following occlusion of the pruning wound

Score	0	1	2	Total
No. of stubs	41	53	10	104
Fraction of stubs (%)	39.4	51.0	9.6	100

Occluded bark and the uniformity of occlusion

Table 6 shows the score for occluded bark and the number and percentage of branch stubs assigned a score relative to the position of occlusion. Figure 1 shows the percentage of stubs for each occlusion position against the score for occluded bark. The difference between bottom (B) and middle (M) occlusion positions with respect to the degree of occluded bark is significant at the 0.05 level. Other differences are not significant.

Pruning at the correct position and angle such that uniform occlusion occurs has the potential to reduce the incidence of occluded bark at the end of the branch stub.

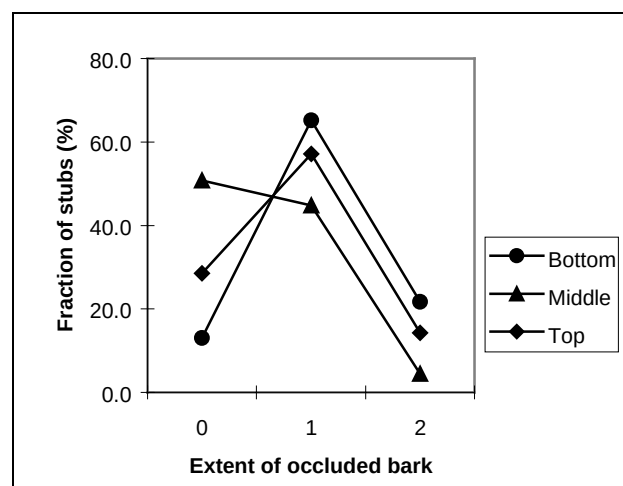


Figure 1. Incidence of occluded bark relative to the position of occlusion (bottom, middle, top) at the end of the branch stub.

Branch diameter and branch angle

No relationship between the branch diameter and the extent of occluded bark, occlusion position or extent of decay was found, nor were any relationships apparent between the branch angle and the degree of occluded bark, extent of decay or occlusion position.

Only one branch with a diameter of 30 mm or more was observed to have fully occluded. However, branches of this size were predominantly found towards the top of the pruned stems. Having been pruned later than branches lower on the stem, they had had less time to occlude than lower ones.

In total, eight branch stubs of 30 mm to 40 mm diameter were exposed. These were the largest branches encountered. Of these eight, five had observable decay contained within one stub diameter and one contained within two stub diameters. Of the remaining two, one branch (37 mm) had no visible pruning damage yet decay had spread to the centre of the tree. The other branch (40 mm) was damaged during pruning. Decay had spread to the centre of the tree and was in an advanced state.

Table 6. Occluded bark and its relationship to occlusion positions (B = bottom third; M = middle third; T = top third)

Occlusion position	B			M			T		
Mean score	1.09			0.54			0.86		
Score	0	1	2	0	1	2	0	1	2
No. of stubs	3	15	5	34	30	3	4	8	2
Fraction of stubs (%)	13.0	65.2	21.8	50.8	44.7	4.5	28.6	57.1	14.3

Insect activity

Only two exposed stubs were found to have any evidence of insects. Insect(s) had entered one branch

location via occluded bark within the branch bark ridge. Occluded bark within the branch bark ridge results in weak branch junctions with the stem. Damage may have occurred prior to pruning. Branch weight and

wind can cause splitting along the branch/stem junction, thus providing entry for insects and decay. Extremely poor occlusion had occurred, extensive decay was present, with staining of the outer bark by phenolic compounds visible in the standing tree.

The largest-diameter branch encountered (40 mm) highlights the importance of stub-cutting large branches. The branch stub was damaged (split) and bark below torn as the branch fell during pruning. Bark tearing resulted in a significantly larger wound and slow occlusion. Insects entered the damaged branch stub and decay proceeded to the centre of the tree.

Conclusion

Blackwood appears to respond well to clearwood pruning, provided a high standard of pruning is achieved and the tree has the genetic ability to compartmentalise decay.

Pruning inflicts unnatural damage. Minimise the damage by avoiding bark tearing and branch splitting. This is best done by stub cutting at a distance of 15-20 cm from the stem. The stub can then be removed with virtually no risk of tearing bark or splitting the branch. This will ensure rapid occlusion and reduce the potential for further decay and insect infestation.

Most authors advocate removal of branches before they exceed 30 mm in diameter. While this study found most branches larger than 30 mm had decay compartmentalised within one branch diameter (excluding those with pruning damage), the sample was small. It is recommended that existing literature be adhered to and branches be removed before they exceed 30 mm.

The extent of occluded bark can be minimised when even occlusion of the branch stub occurs. However, most occluded bark encountered in this study would be contained within the defective core. Provided a clean cut is made with minimal damage to the bark and associated cambium around the branch stub, small

amounts of occluded bark should not detract from recoverable clearwood volumes.

Discoloration associated with the compartmentalisation of decay was evident in all but six of the 147 branch stubs exposed for this study. Provided decay and discoloration is contained within the defective core, recoverable clearwood volumes should not be reduced. It is likely, however, that a small fraction of trees within any population will be particularly susceptible to decay. One tree out of nine in this study had occluded completely by age 11 years, and looked excellent from the outside, but extensive decay was found within the tree. It is possible decay would have progressed into the clearwood zone had this tree been grown on, or the tree might even have died prematurely as a result of decay organisms entering branch stubs following pruning.

You only get one chance at pruning a branch correctly. Once unnecessary damage has been inflicted it can't be corrected. It is important to understand the correct pruning techniques and to utilise high-quality pruning equipment that can help to minimise pruning damage.

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12

On-Farm versus Sawmill Processing – Some Farm Forestry Issues

Andy Warner

Private Forests Tasmania, Burnie

Introduction

Private Forests Tasmania (PFT) is a small government authority that provides independent advice to farmers on all aspects of the sustainable management of trees on private land. Both native forest and planted trees can provide a range of uses to the landowner including:

- Soil, water and vegetation conservation;
- Wood production;
- Shelter for crops or livestock; and
- Amenity benefits.

PFT and earlier incarnations (such as the Private Forestry Division of the old Forestry Commission) have encouraged landowners to consider growing ‘non-mainline’ species, with the emphasis indicated by the change in the general description of such species as blackwood, myrtle and sassafras from ‘minor species’ in the 1980s to ‘special species timbers’ in the 1990s.

This discussion considers some of the issues associated with processing blackwood on private property in Tasmania.

The main interest in blackwood on private property in Tasmania is associated with ‘paddock trees’ (Fig. 1) and native forest stands (Fig. 2).



Figure 1. Paddock trees provide valuable shade. Unlike eucalypts, blackwoods allow pasture growth up to the trunk and so are a preferred livestock shade tree by landowners.



Figure 2. Typical blackwood trees in NW Tasmania grazing country; the trees are mainly along drainage lines

Plantation activity with blackwood has focussed on the use of a nurse crop, with the oldest plantings still many years from commercial harvest (Fig. 3).

Recent work by people such as Ian Brown and Ian Nicholas in New Zealand suggests there may be additional options to consider.

Native forest blackwood has provided some insight into the issues that will need to be addressed for sustainable harvesting from private property.



Figure 3. Private Forests Tasmania blackwood demonstration site at Abbotsham in NW Tasmania at age 18 yr. The nurse crop of radiata pine has been removed and the blackwoods recently thinned.

Getting the logs

The Tasmanian Forest Practices Code requires a Forest Practices Plan (FPP) for most harvesting of timber regardless of ownership. The process requires detailed assessment of a range of environmental factors to ensure that soil and water quality as well as rare and endangered species are not adversely affected by the proposed activity. The cost of preparing a plan is usually \$500 - \$1000 if there are no complex issues.

All major processors are required to ensure that their logs are obtained from operations that are covered by a current FPP. While a small private operation may involve only a few paddock trees, often the blackwoods are associated with watercourses that may be habitat for endangered species of freshwater crayfish. This

presents challenges to any 'simplified' process for harvesting, and can place extra financial burdens on the harvesting of small volumes given current returns.

Sawing issues

Open-grown trees may have old fencing wire or nails embedded in the trunk, and there may be larger bark fissures or buttressing, or damage from stock rubbing or insects.

The landowner may also have little or no experience in the issues associated with harvesting or further processing and may simply find it easier to 'burn the trees' if the blackwoods are a part of pasture expansion. Problems associated with harvesting the standing old-growth may discourage the landowner from considering blackwood as a possible future plantation species, without the silvicultural issues even being considered!

Sawmills with kilns need to produce some longer boards (about 5.5 m) to build the sides and base of kiln loads. Such boards are unlikely to be cut from paddock trees.

Slicing blackwood for veneer offers increased returns per cubic metre, but only select flitches can be successfully used. Flitch size varies, but 150 mm x 75 mm upwards is common. Large logs are not necessarily better, depending on bark sleeves, veneer slice quality and hardness of the tree.

Tasmanian blackwood is considered to be harder than the local ash eucalypts (*Eucalyptus obliqua*, *E. regnans* and *E. delegatensis*), but not as hard as peppermints (*E. amygdalina* and *E. nitida*).

Portable sawing

The Lucas mill and a range of other brands of portable mills are used in Tasmania, with landowners usually encouraged to pay a 'per hour' cost (about \$40-\$45 hour⁻¹). Tailing-out by the landowner helps to increase productivity.

Local experience indicates that the larger Macquarie mill can cut up to 300 mm x 175 mm, whilst the Lucas with a 16 hp motor cuts up to about 150 mm x 150 mm, although there is also a larger Lucas mill (25 hp) that cuts up to 200 mm.

There are, however, important occupational health and safety issues to be considered before using untrained assistants for tailing out and offsidings. For example it is generally considered safer to have the tailer-out work from 'behind' the saw operator so that any sloven from the saw cut is not thrown towards the tailer-out.

Fixed-bench sawyers need to recalibrate their expertise for portable mill sawing – 'saws ain't saws'!

The set-up of the portable mill is important. The base supports need to be firm so that there is no sinkage and

consequent distortion of the cut in the square frame of the saw.

With a portable mill, each board is individually cut off the log rather than off a slab on a second sawbench as occurs in a larger fixed mill. Consequently, to cope with growth stresses, portable mills often work only on 3.1 m logs (sometimes up to 5.2 m) as longer lengths tend to warp and bow as the tension is released during each saw cut. There is no opportunity to use on-site kilns to assist with reconditioning.

There is considerable speculation regarding the sawing quality of plantation-grown blackwood. Research will be needed as plantation logs become available, as experience with eucalypts indicates that faster-grown trees do have different sawing and drying properties. Overseas experience (New Zealand for example) may be useful.

What's it worth?

Blackwood stumpages

Indicative log prices are shown in Table 1. Combined forest industry standard specifications generally apply (Table 2).

Table 1. Indicative current log prices, Tasmania

Grade	Stumpage (\$ m ⁻³)
Category 4	60-70
Utility	15

Table 2. Forestry Tasmania specifications for special-species sawlogs

Sawlog Category 4 and Utility Special Species Timber Sawlog		
Specifications for silver wattle, blackwood, sassafras, celery top pine, leatherwood, tea tree and other Special Species timbers.		
Note: Myrtle, huon pine and King Billy pine specifications are on separate cards. Blackheart definition in on SST Notes card.		
Specification	Cat 4	Utility
Minimum length	3.1 m	2.5 m
Min. small end diameter	30 cm	25 cm
Limbs and bumps	3 of 4 faces clear (in 3.1 m lengths)	2 of 4 faces clear (in 2.5 m lengths)
Spiral	1 in 8	1 in 8
Sweep	1 in 7	1 in 7
Scars	¼ face – 3.1 m in 3.1 m	½ face – 2.5 m in 2.5 m
Borers	Nil evident	No significant evidence
End defect	End diameter 30-40 cm ub – minimum of 10 cm radial ring clear of heart and sap. End diameter >40 cm ub – as per Sawlog End Defect Limits Table.	End diameter <30 cm ub – nil. End diameter 30-40 cm ub – minimum of 10 cm radial ring clear of heart and sap. End diameter >40 cm ub – as per Sawlog End Defect Limits Table.

Blackwood boards and flitches

Local information suggests the values shown in Table 3. Recovery from paddock trees with a portable mill is variable, but can be as high as 20% select and 30% feature grade.

Table 3. Value of blackwood boards and flitches, Tasmania

Grade	Value (\$ m ⁻³)	Common sizes	Comments
Green Select	900-1100	28 mm thick; 50 mm, 75 mm, 100 mm and 150 mm wide	Flat or back sawn at top end, quarter sawn at lower end of value/m ³ range
Green Feature	300-450	28 mm thick; 50 mm, 75 mm, 100 mm and 150 mm wide	'Black & white' must have <50% width as sap
Green Veneer Flitches	1200 +	2.8 m long; 150 mm x 75 mm upwards	

Blackwood boards - kiln dried retail in Burnie

The price of kiln-dried boards is indicated by Figure 4. The value added by kiln drying and retail margins etc. is substantial: the price in the log of a 100 mm x 25 mm board, allowing about 25% for sawing and drying waste, corresponds to about \$2000 m⁻³.

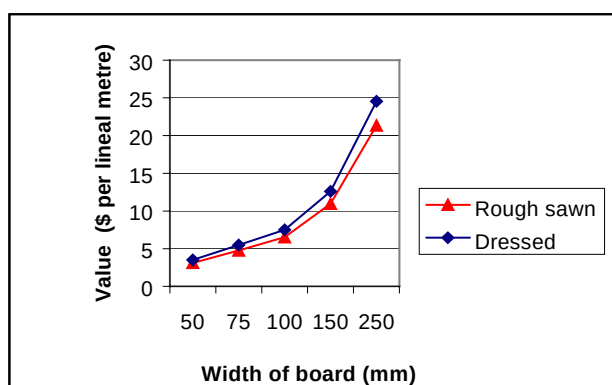


Figure 4. The relationship between price per lineal metre and board width for kiln-dried blackwood boards nominally 25 mm thick

Future issues

Predicting the future is always fraught with danger, but perhaps some of the following may influence the rate of development or extent of blackwood plantations.

There is no doubt that quality blackwood furniture, contemporary as well as antique, can command premium prices as recent auctions show (see the frontispiece of these proceedings). A major challenge for the future is to position blackwood as a preferred timber for high-value furniture. While the superior characteristics of blackwood have been recognised since European settlement in Australia, showing that the timber has been grown and harvested under **internationally accredited standards** could provide an important marketing edge, or perhaps even be a mandatory requirement. The international options for the type and content of such standards are currently being actively debated.

On-line eMarketing or 'selling in cyber space' may provide some opportunities for reaching an increased market. This will depend, however, on establishing acceptable quality standards that can provide some confidence to the buyer about the log or board specifications. Second-generation Pruned Stand Certification processes (being advocated by Australian Forest Growers, and along the lines of the NZ system) may play a role.

Informed growers will play an increasing part in ensuring that, like other farm produce, trees earn their way. This may well include a broader understanding of the contribution that trees such as blackwoods can make to the whole farm output. This could mean that a dollar value is not only identified for the wood products created from harvesting these trees, but also for the crop and livestock shelter, and soil, water and vegetation conservation and amenity values that to date have not been used in most financial analysis.

One example of encouraging the information flow in Tasmania is via the Farm Forestry Toolbox – a user-friendly set of computer programs packaged with on-line help on a CD-ROM that can run on most home computers. PFT developed the package with National Heritage Trust funding and substantial assistance from Forestry Tasmania and the CRC for Sustainable Production Forestry. Current stumpages on their own do not provide sufficient incentive for substantial investment in blackwood plantations. However, the Toolbox can be used to assess the impact of a change in stumpage, recovery or other factors on financial returns.

Figure 5 shows the Single Tree Inventory Tool that facilitates analysis of the likely log volume and value of a blackwood tree, based on user-defined log grades and values in conjunction with user-defined tree height and DBHOB.

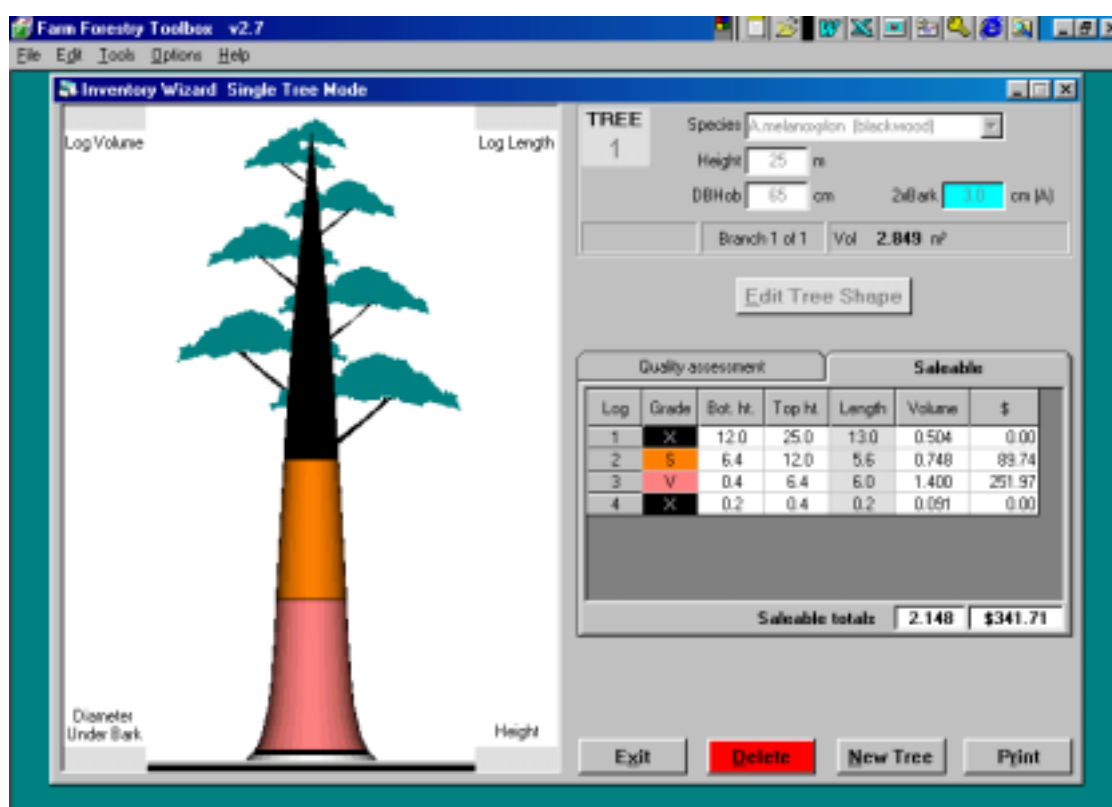


Figure 5. The Single Tree Inventory Tool from the Farm Forestry Toolbox

Conclusion

There is room for improvement in all aspects of the blackwood cycle - **a better understanding** and analysis of the costs and revenues from seedling to sold product, **improved silviculture and processing techniques** and a **successful marketing push** to increase the final value of blackwood products.

The major and enduring challenge for all of us involved in blackwood is not to claim a part of someone else's piece of the blackwood cake, but rather to make the cake larger for everyone!

13

Blackwood...World-class Cabinet Timber... ..This is why we're here!

Suzette Searle

PO Box 201, O'Connor, Canberra ACT 2602

In the beginning...

After listening to the presentations today, there is no doubt that now, as never before, we are building a practical knowledge of how to grow and process quality blackwood. But before talking a little about what else can be done, I'd like to share with you when and where this whole idea of the Blackwood Industry Group (BIG) began... because I was there.

I was there when the BIG seed was sown. It was four-and-a-half years ago in a coffee shop on the ground floor of the Dong Fang Hotel, in the bustling trade city of Guangzhou, south-east China. I wasn't alone. Alan Brown from CSIRO was sitting across the table from me. We'd been travelling all over Guangdong province looking at acacia trials set up by Chinese scientists. And they were keen... really keen on growing blackwood! And Alan and I talked as we sat there drinking our coffee about what it would take to get Australians keen on growing and promoting blackwood before some other country produced it better than we did. There and then Alan suggested we organise a national meeting. When we got back to Australia, Alan talked about the idea with Roslyn Prinsley from RIRDC and she suggested we talk it over with Rowan Reid of the University of Melbourne. And so the first meeting of all those interested in the growing, processing and marketing of blackwood came about seven months later in November 1996 at Lorne in Victoria.

Progress in China

But let me go back to China because our colleagues have done a lot in the four years that have passed since that fateful visit.

Alan and I and several other CSIRO scientists during the 1990s were working on temperate acacias in China as part of Australia's aid program through that most marvellous organisation – the Australian Centre for International Agricultural Research. (I say most marvellous because ACIAR has a vision and a level of funds that seem so hard to find elsewhere).

Blackwood had been introduced to China sometime between the 1950s and its inclusion in ACIAR trials in 1986, but it was never planted on any scale. And it

wasn't until the 1990s that we began to look more closely at provenance variation in the species, establishing trials in the hilly regions of southern China. It was then that our Chinese colleagues became really interested because blackwood grew well at altitude in the tropics of south-east China. Study trips to Australia to see this wonderful species growing at its best, and how we turned it into sawn timber and veneer for the specialty timber market also inspired our Chinese counterparts.

So our Chinese forestry colleagues were keen, especially a forward-looking young scientist called Zhang Fangqiu who heads up acacia research at the Research Institute of Tropical Forestry (RITF) in Guangzhou. Mr Zhang and his colleagues were so interested they did two things. First, they planted a demonstration trial to attract attention – a provenance trial of blackwood right a long a busy highway, close to a golf course if I recall correctly, with the idea that lots of people would see it, including those with influence, funds and land. Secondly, they began a breeding program, for two reasons – to identify the best material for plantations, and to provide enough planting material to meet the inevitable demand.

So where is China right now with blackwood after less than a decade of experimental plantings? They've done more than we have in the same time, and it's an illustration of what can be achieved.

Well, at the moment Mr Zhang has identified blackwood provenances from south-eastern Queensland as the best for plantation establishment in the short term. He has converted three blackwood provenance-progeny trials into seed orchards. These were planted in 1996 and made up of 299 families from 36 provenances. Mr Zhang has made some early selections of the best provenances and families; and identified the greater importance of between-family variation rather than between-provenance variation. RITF has established another 20 ha of seed orchards across four sites, and is in the process of establishing a clonal seed orchard. Grafts, tissue culture and cuttings from superior individuals within families will be used to create clones. Chinese experience has shown that blackwood must be grown on good soils with sufficient moisture and fertility – unless you want to grow shrubs

– and they are looking at planting densely (about 2500 stems ha⁻¹) in pure stands to control stem form.

A week ago, Mr Zhang described the interest in growing blackwood in south-east China as follows, and I quote:

In some places like Fujian and eastern Guangdong province, the advantages of abundant moisture and nutrition, relatively cold weather and relatively developed economic conditions have encouraged more and more people to plant blackwood for high quality wood. About 500 ha of blackwood plantation have already been established. The demonstration provenance planting of blackwood planted in Dongguan city, north of Guangzhou, had a good effect and now many companies want to develop blackwood plantation. But the shortage of seed greatly restricts their efforts. When this problem is solved, the development of blackwood plantations in China will be greatly enhanced.

So there you have it!

Action in Australia

So what should be happening with blackwood back here in Australia? I'm sure every one of you has an idea about what needs to happen to establish confidence in the growing, processing and selling of blackwood. And let not this meeting end before you let others know what you want! But as I have the floor, here are a few thoughts of my own.

Improving nature's gift

Ultimately I want to be able to hold in my hand a blackwood seedling, graft or cutting with the same confidence I could hold a radiata pine seedling – knowing that in my hand is something that will grow the quality of trees that industry will pay a good price for.

I want to see a national breeding program in place that is based on extensive sampling and testing of natural populations. When a grower wants to plant blackwood I want them to have no difficulty in getting the number and quality of seedlings they require, along with the latest advice of how to grow them for a particular market.

So what's happening in Australia with research on and development of other native high-value specialty timbers? The other so-called minor species in forestry. Let's look at that Aussie icon, red cedar.

Now I love red cedar but it's got a problem. It can't be grown commercially out of the natural forest! This rather significant disadvantage in terms of cultivation is caused by a small moth that loves to burrow through red cedar's growing shoots and invariably mucks up the form of the tree. Now do you think that's put researchers off? No! Do you think that's put national

and international research funders off? No! Despite this huge hurdle, funds have been made available. Red cedar research in Queensland and NSW to understand the insect and develop helpful silviculture is being funded by the Natural Heritage Trust, Queensland Department of Primary Industry, the Rural Industries Research and Development Corporation (RIRDC), CSIRO Entomology, CSIRO Forestry and Forest Products, and the Australian Centre for International Agricultural Research (ACIAR). So why can't we get more funding for research to breed, process and market blackwood – a species we have no problem growing and one that has a much more versatile wood? Maybe we haven't asked the right organisations? Is it a marketing problem? Maybe we blackwood lovers have got to get a bit more romantic, and convey the history and versatility and beauty of blackwood to the world! Red cedar even has a book about it, called *Red Cedar - The tree of Australia's history*. Maybe we should produce a beautiful, nostalgic coffee-table book that describes the history of utilisation of blackwood. Anyway I believe if we want to promote an Australian cabinet timber, blackwood has more chance of a successful outcome than our beloved red cedar. You've just got to convince the research funders of that!

Marketing

A great name?

Now talking about marketing. What poet laureate came up with the name blackwood? It's not even descriptive! Why, this wood is golden brown with waves and highlights, depth and life in its beautiful grain. It's not black! Usually tree namers are a little bit more helpful. I mean you have silky oak, blackbutt and red gum for example. Maybe the reputation of blackwood as a quality cabinet timber has risen above its common name. Maybe it's up there with one of the largest trees in the world – the mighty Californian redwood, which despite its magnificence, has a pretty ordinary name.

So I suggest we think of a new name for blackwood. Denis Brown (Corsair Sustainable Timbers) of Yackandandah, Victoria, has done just that. If you look on his web site (www.tablesaside.com.au/) where he sells furniture made from *Acacia melanoxylon* and *A. dealbata* over the Internet, you will see that he calls them golden and silver wattle. Well, actually he calls *A. melanoxylon* the Victorian golden blackwood. Now that's not bad! It has also been called Australian teak in the furniture trade.

So let's think of a name that describes the glorious variation in this beautiful wood and captures the attention and emotions of those buying or recommending cabinet timber. What about Australian goldenheart, forest velvet, golden lustrewood, golden ripple if you're talking about fiddleback wood; Tassie tigerwood for the strongly striped wood; swamp chocolate? Now that's attractive!

A green image?

And what about people's desire to buy wood from sustainably-managed forests? That's got to be an advantage for the blackwood industry. It was only the other day I bought some notepaper to discover that on the back was written:

All paper made from trees grown in sustained forests. Made in South Africa.

The claim of sustainability is obviously seen as a marketing advantage. And in a world where more people than ever are concerned about the management of forests, this is another characteristic of blackwood we could promote, whether it comes from sustainably managed native forests, plantations or farm forestry plantings. And what about promoting blackwood as a substitute for unsustainably-managed rainforest cabinet timbers? That's got to be another plus!

Don't be gazumped!

Now I have another comment to make, and I don't want our New Zealand colleagues to feel uncomfortable because, when it comes to marketing, we Aussies could learn a lot from across the Tasman. Oh, of course we had the West Australians claiming Tasmanian blue gum as their own by calling it western blue gum. But that's nothing compared with the New Zealanders! The Chinese gooseberry totally lost its identity as they carted it south of the equator, claimed it as their own, and now we have kiwi fruit! Now if we don't move

quickly, those New Zealanders are going to take our blackwood and call it their own All Black Wood!

Demand!

Now it was at our meeting in Lorne four years ago that the inspirational Bob Moody (who was with FURNaHOME Melbourne at that time) described the importance of demand. Bob described demand as the train engine that pulled all aspects of the industry behind it. Without demand, why grow blackwood; why process it; why try to sell it? It was a good message and one that we have yet to act upon as a group. Denis Brown called me only last night to ask that, as a group, we consider the need to develop an international market for blackwood because the Australian market is small, and when looking at export markets, we must value-add.

So it would be really BIG if the industry got together to create a much bigger international demand for blackwood. A demand for this durable, beautiful, versatile sustainably-grown Australian cabinet timber – blackwood!

And finally?

So what's my final word? Let's keep going as a group. We have everything to gain by sharing knowledge and seeking funding together. And let's think BIG.

Field Day

Compiled by Maria Cherry

Meunna

Bill Neilsen
Forestry Tasmania

The two research trials visited were on a frosty site at Meunna, North-West Tasmania, at 250 m altitude and with an annual rainfall of 1600 mm.

Trial 1.

Introduction

A trial covering 20 ha was established in 1988 to determine the potential of *Acacia melanoxylon* (blackwood) as a plantation species when grown alone and in combination with cover crops of *Pinus radiata*, *Eucalyptus nitens* or *E. globulus*. The field visit focused on the more promising planting treatments of blackwood and cover-crops.

Treatments

Various combinations of spacing, thinning and pruning were investigated. The trial consisted of block plantings of 25 treatments. There were four replicates. Plots were all 0.2 ha with dimensions of 12 rows (39.6 m) by 50 m. The 25 treatments included 6 blackwood-only treatments, 7 blackwood under *P. radiata* treatments, 6 blackwood under *E. nitens* treatments, 5 blackwood under *E. globulus* treatments and one *P. radiata*-only treatment.

Results and discussion

Despite fencing, and poisoning with 1080, browsing by rabbits had a major influence on the growth of many of the blackwood: the slow growth of many seedlings led to suppression due to weed competition. The weed control conducted in the first year after planting was insufficient to prevent the later competition from weeds. Severe frosting throughout the trial area at age 1 year affected both the blackwood and the *E. globulus* cover crop. Frosting continued to affect the blackwood to age 6 yr. By this age, survival was 81%. Survival varied, being poorest in the plots without cover crops. Growth of blackwood was poor due to repeated frosting. Growth of the *E. nitens* and *P. radiata* was good.

Using a mechanized harvester, the eucalypt pulpwood cover crop was removed with little damage to the blackwood.

Trial 2.

Introduction

A trial was established in 1989 using blackwood seed collected from 127 Tasmanian trees of superior phenotype, with attention being paid to high and low altitude seedlots. Six mainland provenances were supplied by the Australian Tree Seed Centre of CSIRO Forestry and Forest Products.

Treatments

The trials consisted of block plantings of the blackwood provenances under a *P. radiata* cover crop. There were two replicates. Plots were all 0.2 ha with dimensions of 12 rows (39.6 m) by 50 m. Four hundred stems per hectare (sph) blackwood and 800 sph *P. radiata* were planted in a row-for-row pattern with the blackwood at 3.8 m spacing and the *P. radiata* at 1.9 m spacing.

Results and discussion

Severe frosting and browsing by rabbits has had a major influence by restricting growth of many of the blackwood. Recently the cover crop was thinned to waste and pruned but is still competing seriously with the blackwood.

The northern mainland provenances showed below-average height growth and survival. The provenances obtained in New South Wales and Victoria have behaved similarly to Tasmanian provenances. There were significant differences in height growth and survival between provenances.

References

- Neilsen, W.A. and Brown, D.R. (1996). *Acacia melanoxylon* plantations in Tasmania, Research and development. Forestry Tasmania., 193 pp.
- Neilsen, W.A. and Brown, D.R. (1996). Blackwood plantation development in Tasmania: research and development. Paper presented to the workshop *Growing Australian Blackwood (Acacia melanoxylon) for Timber*, Lorne, Victoria, Australia. November 1996. 12 pp.
- Neilsen, W.A. and Brown, D.R. (1997). Growth and silviculture of *Acacia melanoxylon* plantations in Tasmania. *Tasforests* 9, 51-70.

Abbotsham

Andy Warner
Private Forests Tasmania

Introduction

The trial was established on the property of A. & C. O'Neil in 1982 at Abbotsham, North-West Tasmania, with the assistance of a Special Species Grant.

The site is of high quality with tertiary basalt soils and an annual rainfall of 1200 mm. *Acacia melanoxylon* (blackwood) occurs naturally in the area. The site, previously established pasture, was selected to utilise steeper slopes and provide shelter to the rest of the property. The aim of the planting was to produce high value blackwood veneer using *Pinus radiata* as a nurse crop. The aim in planting the nurse crop was to provide a reduction in side light to the young blackwood trees to 'force' them to grow straight and tall with minimum heavy side-branching.

The site was cultivated and mounded and planted to blackwood and *P. radiata* in 1982. The planting was in 0.6 ha blocks with *P. radiata* as the nurse crop. Herbicide spray was used for initial weed control. The blackwood was planted at a stocking of about 800 stems per ha (sph) and *P. radiata* at about 2300 sph (1.8m x 1.8m grid). The blackwood were bagged for browsing protection.

Treatments

Form pruning of the blackwood within plot 1 (see below) was undertaken in 1986 in order to remove any large side branches that would have degraded tree form. Chemical thinning of the *Pinus radiata* nurse crop using frill cutting of the bark and inserting glyphosate was undertaken in 1989 and again in 1992. Neither of these applications was very successful with few of the nurse crop trees dying. Active management of the site lapsed.

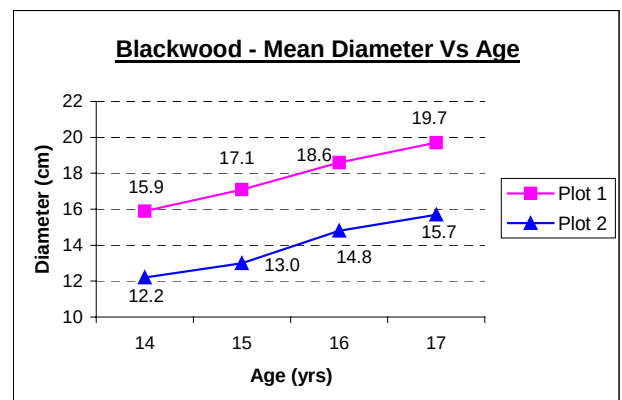
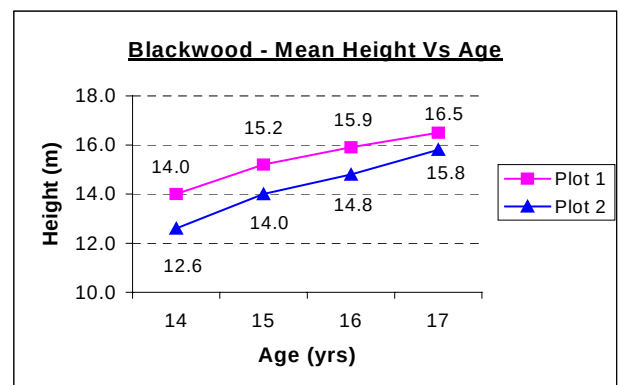
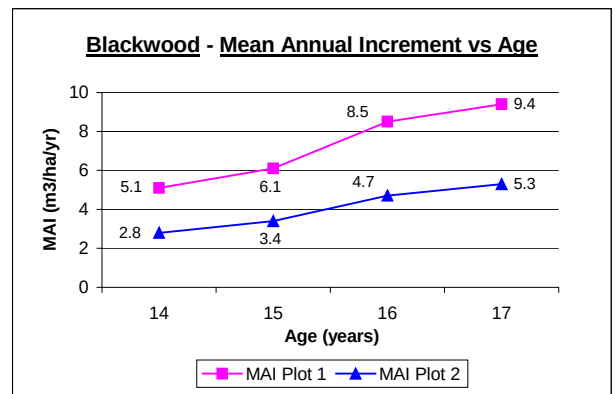
The site was re-evaluated in 1996 and well-formed blackwood was pruned to at least 6.4 m. As falling of the nurse crop posed a serious threat of severe damage to the blackwood, the remaining dominant pines were ringbarked. The slow death and decay of these trees would allow time for the blackwood to increase their wind firmness. Over 18 months, the pines progressively lost vigour and died. Follow-up ring barking was applied to the more resilient trees.

Results and discussion

Two permanent plots were established in 1996 and have been measured annually. Graphs below show some of the analysis. Growth rates are expected to increase as the competing nurse crop of *Pinus radiata* dies. At age 16 yr (1998) a noticeable increase in the MAI for plots 1 and 2 had occurred that is likely to be attributable to

the ringbarking of the pines at age 15 and subsequent crown increase within the remaining blackwoods.

The following graphs indicate the variability in growth rates within the two plots.



This variability may result from a number of factors, such as:

- Seedling genetic diversity;
- Competition from pines;
- Initial weed control; and
- Soil depth and moisture

The largest of the blackwoods (tree 34 plot 1) has attained a diameter of 37.5 cm and a height of 20.2 m at 17 yr of age. This tree is one of the few that had an early release from competition, with all four of its 'nurse' trees either dying or being severely stunted in

the early chemical applications. It gives a good indication of what could be achieved.

Ringbarking of the pines in 1997, at age 15, should greatly influence the growth of the blackwood. We expect future measurements to show an increase in diameter growth and a slight reduction in height growth as the crowns spread in response to increased light around the blackwood canopies.

Plots 1 and 2 have recently been thinned (at age 18 yr), reducing the stocking of suitable crop trees to approximately 200 sph. Average diameter and height for retained trees within plot 1 is 26.1 cm and 18.7 m, while within plot 2 it is 22.5 cm and 17.2 m respectively. Compare these figures with the mean height and diameter for plots 1 and 2 prior to thinning at age 17!

Beulah

Nutrition and Growth

Libby Pinkard
Forestry Tasmania

Introduction

An experiment was established in August 1998 at Beulah (northern Tasmania), in a 6- and an 8-yr-old stand of *Acacia melanoxylon* (blackwood) grown with a *Pinus radiata* nurse crop. The objectives were (1) to determine whether blackwood growth could be increased with fertiliser application, (2) to identify the physiological factors that were affecting growth responses, and (3) to identify an appropriate fertiliser regime. The *P. radiata* was established at 800 stems ha⁻¹ (sph), and the blackwood at 500 sph, with both the blackwood and *P. radiata* managed for clearwood production. Planting design was 2 rows of *P. radiata*: 1 row blackwood, with the *P. radiata* spaced at 5 m intervals and the blackwood planted between every second row of *P. radiata* (i.e. 2.5 m distance from the nurse crop rows and 10 m between blackwood rows).

Treatments

There were 5 treatments: an unfertilised control, nitrogen (N) applied at 200 kg ha⁻¹, phosphorus (P) applied at 68 kg ha⁻¹, a combination of N and P, and the

N and P combination applied as a half dose over two years. Magnesium (Mg) was applied to half of each plot. Treatments were replicated three times at each site, in plots of 40 x 40 m. Height and diameter at breast height (DBH) of the blackwood and *P. radiata* were measured at six-monthly intervals. More detailed measurements of biomass partitioning, leaf area development, photosynthesis and foliar nutrient concentrations were made at the younger site, and soil samples were taken three years after treatment to look at root nodulation and soil nutrient concentrations.

Results and discussion

Height and diameter responses two years after treatment were complex. Trees responded to applications of either N or P, but responses differed between sites (Fig. 1). Mg application had no significant effect on growth. The results are explained to some extent by patterns of root nodulation. At the younger site root nodulation was substantially increased by P application, and there was a trend at both sites for less nodulation following applications of N alone. It is possible that this increase in root nodulation following P application resulted in increased N nutrition of trees in that treatment, thereby confounding growth responses. Foliar samples are currently being analysed.

There were rapid increases in photosynthetic rates following fertilising, but only in response to N. This response was observed only for the first summer following treatment. Increases in photosynthetic rate would be expected to increase growth rates, but this may have been masked by the changes in root nodulation that occurred following P application.

Patterns of leaf area development followed a similar trend to that of height and diameter growth. There was more leaf area on trees in the N treatment six months after fertiliser application, but after that the P treatment caught up.

The response of the nurse crop relative to the blackwood also needs to be considered. Two years after fertiliser application there was a 3 m difference between the heights of the *P. radiata* and the blackwood. Application of N alone reduced this by 0.5 m, and P fertilising reduced it by 1 m.

Monitoring will continue in the experiment over the next few years.

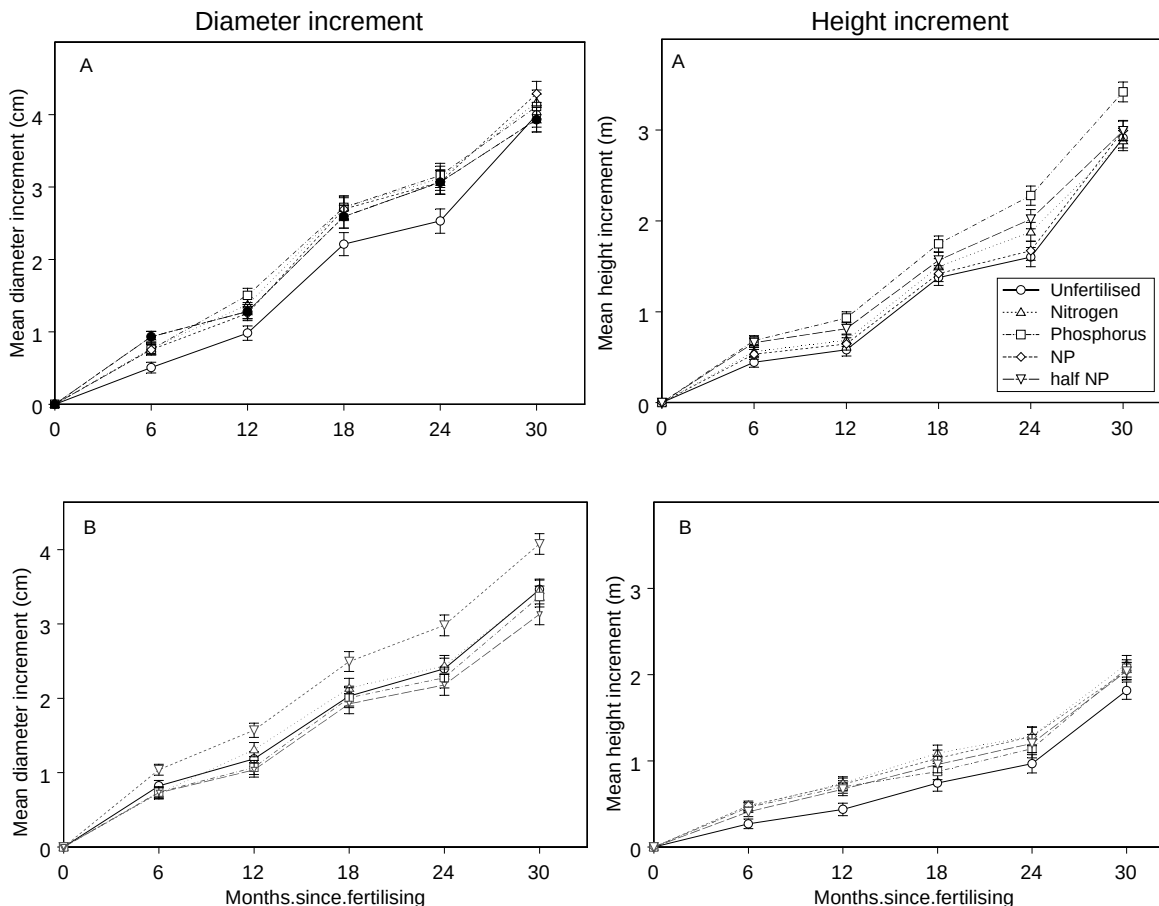


Figure 1. Mean diameter and height increment at a four-year-old (A) and a six-year-old (B) blackwood plantation, in the two years following fertiliser application

Beulah continued...

Physiological Responses to Pruning and Thinning

Jane Medhurst
CRC Sustainable Production Forestry

Introduction

The purpose of the visit to the Beulah thinning and pruning trial was to demonstrate how silvicultural treatment can have a large effect on growth and form when applied to blackwood – nurse crop plantation systems. The site was planted in 1994 with *P. radiata* as the nurse crop. The planting design was as described by Pinkard above. The stocking density before thinning was 500 sph blackwood and 800 sph radiata pine.

Treatments

In the 5-year-old blackwood – radiata pine plantation, various levels of form pruning of the blackwood were

tested by removing prescribed proportions of leaf area from treatment trees. In addition, a range of thinning treatments was imposed on the nurse crop. The effect of these treatments on blackwood growth rate, stem form, rate of crown development, level of crown activity and canopy light environment was assessed.

Results and discussion

Thinning the nurse crop had a positive effect on blackwood diameter growth. However, increasing the thinning intensity of the nurse crop led to increasing deterioration in form, causing reduced height increment and loss of apical dominance. The foliage area of crowns of blackwood trees pruned of 50% of foliage area took 12 months to recover to pre-pruning foliage area levels. However, an increase in photosynthetic capacity of foliage throughout the crowns of these trees minimised the effect of loss of foliage area on growth, provided adequate light levels were present in the plantation. Appreciable changes in the light environment of the blackwood crowns occurred only after more than 50% of radiata pine trees were removed.

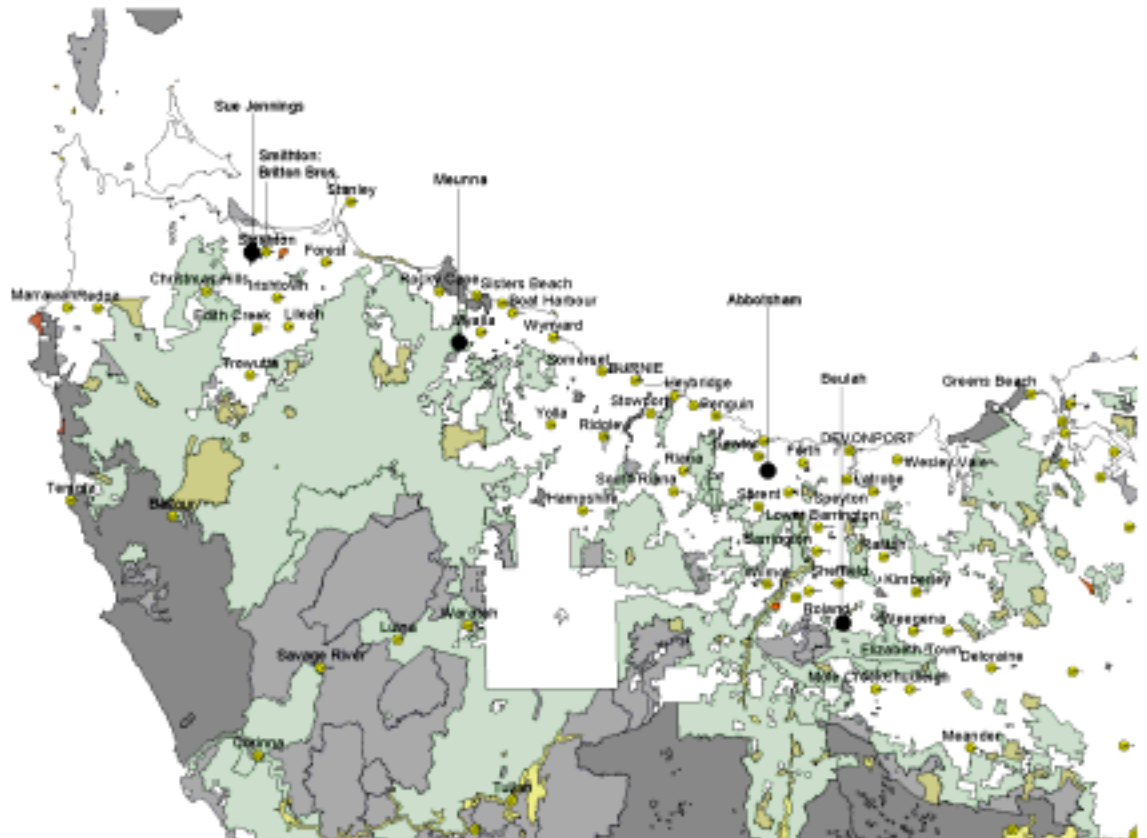
While thinning the nurse crop can improve blackwood growth rates, heavy thinning before a sawlog-length of stem is established will also result in poor stem form. Due to relatively wide spacing arrangements, form pruning is vital for blackwood trees grown with a commercial nurse crop species. A program of early and moderate form pruning, combined with a light thinning of nurse crop trees (at about age 5 yr) should provide the benefits of good stem form and stem growth.

Reference

Medhurst, J. and Worledge, D. (2000). Silvicultural options for plantation-grown *Acacia melanoxylon*: form pruning and nurse crop thinning. Technical Report No. 50. Cooperative Research Centre for Sustainable Production Forestry, Tasmania.

North-West Tasmania

100 km



COOPERATIVE RESEARCH CENTRE
FOR
SUSTAINABLE PRODUCTION FORESTRY
and
PRIVATE FORESTS TASMANIA

Advancing Blackwood Silviculture - a Blackwood Industry Group (BIG) Workshop

Tall Timbers Hotel, Smithton, Tasmania
Thursday 30 November – Friday 1 December 2000

REGISTRATION FEE \$65 (or \$35 for each day)

REGISTER NOW!!

Return completed form to Jean Richmond at:

Email: jean.richmond@ffp.csiro.au or

facsimile: 03 6226 7942 or

post: CRC Sustainable Production Forestry, GPO Box 252-12, Hobart, TAS 7001

by 5.00 pm Friday 17 November.

Name:

Organisation:

Tel:

Fax:

Email:

Preferred method of payment of registration fee is by cheque made payable to 'University of Tasmania'.

If you wish to pay by credit card please contact Jean Richmond as above or by telephone (03 6226 7947).

Please indicate your mode of travel and attendance on the following days:

☐ By air to and from Burnie (Wynyard)¹ ☐ By road

☐ Thursday 30 (sessions)

☐ Friday 1 (field day)

¹Burnie Airport (at Wynyard) is the closest airport but 45 minutes by road from Smithton. There are flight connections from and to Melbourne. For example, on 29th November, flights AN6325, QF2741, and AN 6327 depart Melbourne at 3.25 pm, 5.00 pm and 7.00 pm and arrive Burnie at 4.25 pm, 6.00 pm and 8.00 pm, respectively. Please indicate whether you would like transport from Burnie Airport to Smithton. You can indicate your arrival times later.

- ☐ Transport from Burnie Airport to Smithton

You may require transport on Friday at the end of the field trip from Devonport to either Burnie Airport or Smithton. The bus used on the field trip will originate in Smithton and will return from Devonport to Smithton via Burnie Airport. Specific requirements regarding return travel can be dealt with at the workshop.

Please indicate your attendance at the following meal:

- ☐ Thursday 30 Workshop Dinner. Cost: \$28 (not incl. drinks)

Accommodation

Smithton - Wednesday 29 and Thursday 30

PLEASE NOTE: Attendees are required to make their own accommodation bookings.

Rooms have been reserved at the workshop venue, Tall Timbers Hotel in Smithton. When making your bookings, please indicate that you are attending the workshop.

Tel: 03 6452 2755

Fax: 03 6452 2742

Room tariffs are:

Single rooms: \$77.00 per night

Double/Twin: \$93.50 per night

Triple: \$110.00 per night

Please note that the registration fee covers the cost of hire of the workshop venue, coach transport, and lunch/tea/coffee on each day. All other costs are the responsibility of attendees.



Programme

Advancing Blackwood Silviculture: A Blackwood Industry Group (BIG) Workshop

Location	Tall Timbers Hotel, Smithton, Tasmania
Hosts	Private Forests Tasmania and Cooperative Research Centre for Sustainable Production Forestry
When	Thursday/Friday 30 November / 1 December
Audience	Sawmillers, farm foresters, researchers and any other interested parties involved with the growing, milling and retailing of blackwood
Workshop themes	• What has been happening since Lorne? • Keeping up with the Kiwis • Where are we going with plantations? • Wet sclerophyll for blackwood values • Current market opportunities

AGENDA

Thursday 30 November

8.30 am	Welcome to the workshop (<i>Andy Warner</i>)
8.35 am	Blackwood in its natural setting –managing and using the native forest resource. Chair: <i>John Hickey</i> • Spatial and temporal factors associated with the distribution and growth of blackwood in Tasmania (<i>Mike Peterson</i>) • A new approach to blackwood management in wet eucalypt forest (<i>Sue Jennings</i>) • Understanding the forest light environment – the key to good form (<i>Greg Unwin</i>) • Defining sustainable blackwood supply in Tasmania (<i>Geoff Morris</i>) • Current market opportunities for blackwood (<i>Glenn Britton</i>) • Discussion
10.15 am	Morning coffee
10.45 am	Plantations – defining and improving the options Chair: <i>Bill Neilsen</i> • A historical perspective (<i>Alan Brown</i>) • The New Zealand experience? (<i>Ian Nicholas</i>) • The current experience and new options with nurse crops (<i>Libby Pinkard and Chris Beadle</i>) • The expression of genotype in provenance trials (<i>Des Stackpole</i>) • Discussion
12.15 pm	Lunch

1.15 pm

Farm forestry – maximising growth and form through intensive management.

Chair: *Des King*

- Form pruning in New Zealand (*Ian Brown*)
- Vegetative propagation of blackwood from root cuttings (*Rowan Reid*)
- Pruning, decay entry and discoloration (*Stuart Swanson*)
- On farm versus sawmill processing – what's the difference? (*Andy Warner*)
- Discussion

3.30 pm

Field trip

- Blackwood swamps and wet sclerophyll (*Sue Jennings*)

7.00 pm

Dinner

- After-dinner speech: Blackwood... a world-class cabinet timber (*Suzette Searle*)

Friday 1 December

8.30 am

Field day

- Britton Bros Sawmillers (*Glenn Britton*)
- Meunna - later-age management in industrial plantations (*Bill Neilsen*)
- Abbotsham – later age management in farm forestry (*Andy Warner*)
- Beulah
 - nutrition and growth (*Libby Pinkard*)
 - physiological responses to pruning and thinning (*Jane Medhurst*)

A coach will be used for transport. The field day will finish at the Forestry Tasmania offices in Devonport at 4 pm but the coach will then return to Smithton.

Workshop Participants

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