# EARLY GROWTH AND SURVIVAL OF ACACIA MELANOXYLON: EFFECT OF WEED CONTROL AND FERTILISER

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ABSTRACT

The effects of pre-planting herbicide/spade cultivation and post-planting fertiliser application on early growth and survival of **Acacia melanoxylon** R. Br. (Australian blackwood) were studied for approximately 3 years at a site in the Hunua Ranges of northern New Zealand. Response in height and diameter increment to phosphorus applied as superphosphate was linear up to the maximum rate applied (30 g P/tree). Nitrogen (20 g N/tree) applied as urea had no effect on either height or diameter growth. Tree growth was unaffected by nitrogen × phosphorus interaction and fertiliser × pre-planting treatment. Molybdenum, potassium, and micronutrients afforded no significant growth response. Both diameter and height growth showed positive responses to pre-planting treatment.

Survival was not significantly ($p < 0.05$) affected by pre-planting treatment although there was a difference in the means (98% survival compared with 90% for no pre-planting treatment). None of the fertiliser treatments significantly affected survival.

**Keywords:** Australian blackwood; **Acacia melanoxylon**; superphosphate; urea; herbicide; cultivation.

## INTRODUCTION

Australian or Tasmanian blackwood is being established in New Zealand as one of eight selected special-purpose timber species intended to furnish high-quality end-products not obtainable from *Pinus radiata* D. Don. Blackwood timber will be utilised for furniture and cabinet work, turnery, and veneers (Forest Research Institute 1982a). The species occurs naturally on the eastern side of Australia from Tasmania to south-eastern Queensland, but is found mainly in Victoria and Tasmania. The best natural stands occur in western Tasmania. At present, silvicultural practices in New Zealand are still generally experimental, particularly regarding establishment.

As the degree of sensitivity of blackwood to weed competition and its responsiveness to fertilisers during the establishment phase are largely unknown, a study was designed to determine the effects of pre-planting weed control and spade cultivation, and post-planting fertiliser application on the early growth and survival of blackwood.

## METHODS

The study area was located in Cossey's Catchment, administered by the Auckland Regional Authority (ARA), in the Hunua Range at approximately 240 m a.s.l. The site selected was occupied by grass and mixed hardwood scrub on reverted agricultural land. The existing scrub was roller-crushed and burned 1 year prior to study commencement. The soil was a northern yellow-brown (Te Ranga) with a clay loam textural class. The study followed the standard uniform establishment trial design developed at FRI.

Seedlings were raised in containers from seed obtained from the Tasmanian Forestry Commission and sown in July 1981. Seedlings were planted in December 1981, and were approximately 30 cm tall at planting. This early summer planting date was chosen to encourage the seedlings to make rapid early growth ahead of competing weeds. Also, because of the small size of the seedlings at planting, it was felt that a winter planting could unnecessarily subject them to adverse weather.

The experimental design used was split plot with four replications, each replication being split into two main plots consisting of the following pre-plant treatments:

(1) Minimum – no pre-plant herbicide or spade cultivation; stock planted directly into existing weed growth.

(2) Maximum – pre-plant spot spray of glyphosate (36% a.i.) + simazine (50% a.i.) at the rate of 16 ml diluted formulation per spot. Spray formulation was 450 ml glyphosate and 330 ml simazine in 10 *l* water. The treated spot was spade-cultivated at planting.

Within each main plot, the 11 fertiliser treatments were randomly nested (Table 1). Nitrogen was supplied as urea and phosphorus as superphosphate.

TABLE 1—Fertiliser treatments tested for blackwood

| Treatment number | N | P | K | Other |
|---|---|---|---|---|
| | (g/tree) | | | |
| 1 | 0 | 0 | 0 | |
| 2 | 0 | 7.5 | 0 | |
| 3 | 0 | 15.0 | 0 | |
| 4 | 0 | 30.0 | 0 | |
| 5 | 20 | 0 | 0 | |
| 6 | 20 | 7.5 | 0 | |
| 7 | 20 | 15.0 | 0 | |
| 8 | 20 | 30.0 | 0 | |
| 9 | 20 | 15.0 | 10 | Micronutrients (Zn, Mn, Cu, Fe, Mo) |
| 10 | 20 | 15.0 | | 2 Sodium molybdate |
| 11 | 2.1 | 5.2 | 1.5 | 30 "Magamp"* |

* "Magamp", the source of NPKMg in this treatment, is a granular controlled-release fertiliser (a low-solubility magnesium potassium ammonium phosphate rated 7–17.5–5–12[Mg]).

Experimental units were 10-tree rows in an area planted at a 2 × 2 m spacing in December 1981. The trial area was sprayed with herbicide approximately 1 month prior to planting. Releasing was done by hand in the minimum treatment in February 1982 and February 1983, and the maximum treatment received hand releasing only at the latter date. Fertiliser was applied in spade slits in February 1982. Measurements were made of total height at 0, 1.9, and 2.7 years of age; basal diameters were measured at 1.9 and 2.7 years.

## RESULTS

### Height

The superior height growth in the maximum pre-plant treatment was consistent for all fertilisers but the effect appeared to diminish over time (Fig. 1). Trees in the maximum treatment were nearly 20% larger at age 1.9 ($p = 0.04$) than those in the minimum treatment, but were only 12% larger at age 2.7 ($p = 0.07$). Height growth was increased at the greatest rate of phosphorus fertiliser (Fig. 1). Statistical analysis showed that height growth responded linearly to increasing rates of phosphorus application, independently of nitrogen. There was no height response at any age to nitrogen; mean height at age 2.7 without nitrogen was 2.04 m while mean height with nitrogen

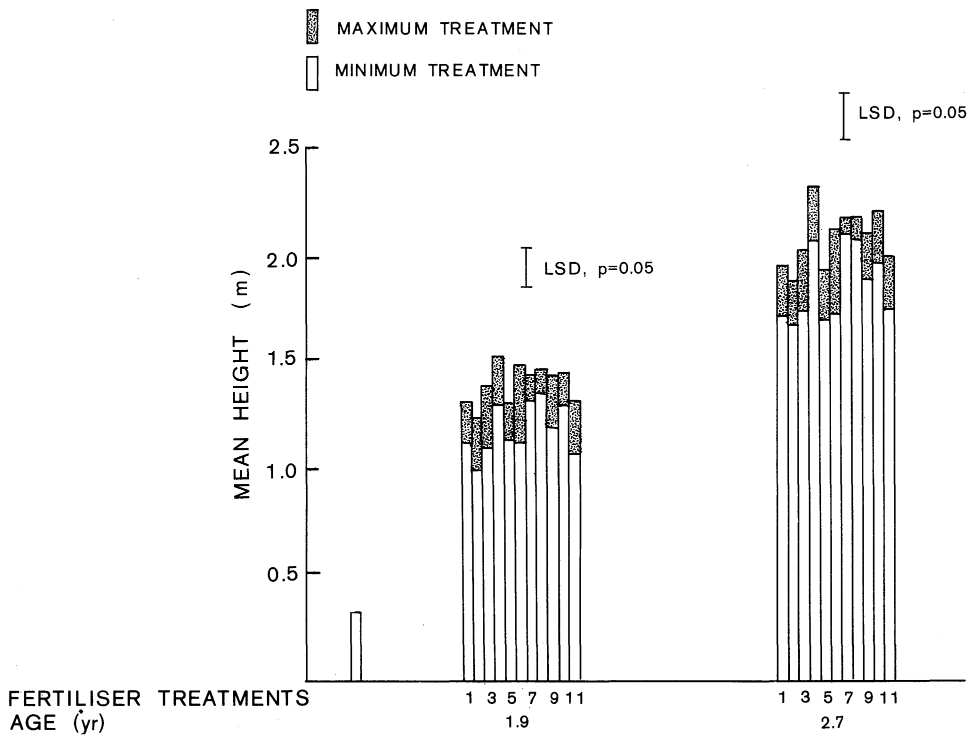


FIG. 1—Mean height development of blackwood with various fertiliser treatments (for explanation of treatment numbers see Table 1).

was 2.09 m, within the maximum pre-plant treatment. Analysis of variance showed no nitrogen × phosphorus interaction nor any nitrogen or phosphorus interaction with pre-plant treatment. The effects of the highest rates of phosphorus (30 g P/tree, Treatments 4 and 8) became more pronounced with age, particularly Treatment 4. Treatments 9 and 10 provided height growth that was inferior only to the higher rates of phosphorus. Magamp (Treatment 11) provided no height growth response but it should be noted that Nicholas (1981) found a significant height and diameter response at 1 year to Magamp at a greater rate (85 g/tree).

## Diameter

By age 2.7, the maximum pre-plant treatment provided consistently superior basal diameter growth in all fertiliser treatments (Fig. 2) over that in the minimum treatment ($p = 0.07$). As with height, basal diameter increased linearly with increasing rates of phosphorus fertiliser. The nitrogen effect on basal diameter was non-significant ($p < 0.05$) for both pre-plant treatments – 3.32 cm without nitrogen and 3.45 cm with nitrogen at age 2.7, within the maximum pre-plant treatment. There was no nitrogen × phosphorus interaction at any age nor any nitrogen or phosphorus interaction with pre-plant treatment. As with height, the diameter growth provided by the higher rates of phosphorus fertiliser increased over time. Treatments 9 and 10 (nitrogen +

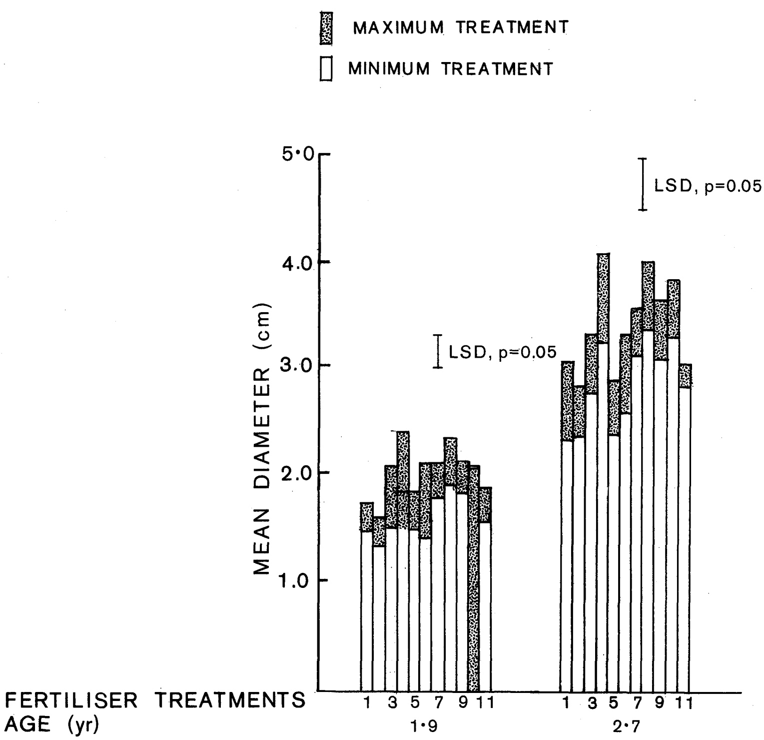


FIG. 2—Mean diameter development of blackwood with various fertiliser treatments (for explanation of treatment numbers see Table 1).

phosphorus + supplements) showed diameter growth not statistically different ($p < 0.05$) from the control and low rates of phosphorus by age 2.7; however, this treatment was significantly inferior ($p < 0.05$) to the highest rates of phosphorus.

### Survival

Analysis of variance showed that neither pre-plant treatment nor fertiliser application had a great effect on survival. Maximum pre-plant treatment provided a 98% survival while survival in the minimum treatment was 90%, but the difference was non-significant ($p < 0.05$).

## DISCUSSION

The growth response due solely to phosphorus is not unexpected as blackwood is a leguminous species capable of nitrogen fixation and, therefore, is largely independent of the soil for nitrogen. It is sometimes advised in agricultural systems to include a small amount of nitrogen in the fertiliser of legume crops at sowing to ensure that the young seedlings will have an adequate supply until the rhizobia can become established on their roots (Tisdale & Nelson 1975). Results from the present study suggest that urea was ineffective as a "starter" nitrogen dose for blackwood since a significant nitrogen effect was not found. Molybdenum, an essential element for symbiotic nitrogen fixation (Murphy & Walsh 1972), provided no significant growth response (Treatment 10 *v.* Treatment 7), indicating at least that molybdenum was not deficient in the soil. Potassium plus trace elements also provided no significant responses (Treatment 9 *v.* Treatment 7), suggesting a similar conclusion concerning potassium and trace element deficiency.

Results from the fertiliser segment of this study have important implications for blackwood establishment in general. Primarily, a response to phosphorus fertiliser at rates of at least 30 g P/tree should be expected on most comparable soil types. The study site soil, a northern yellow-brown earth, is classed as having medium to low phosphate retention status (New Zealand Soil Bureau 1968), yet provided a significant response to phosphorus fertiliser. This suggests that those soils classified as having high to very high phosphorus-retention are likely to be even more responsive to phosphorus fertiliser. Statistical analysis showed that response to phosphorus was linear, indicating that our maximum rate of 30 g P/tree was below "luxury" consumption and that rates above this maximum should have resulted in positive growth responses. Our results correspond well with those of other workers. De Zwaan (1982), working in South Africa, applied nitrogen, phosphorus, and potassium to young blackwood seedlings and after 68 weeks was able to demonstrate significant height response to phosphorus only. Stubbings & Schonau (1983) in a review of the silviculture of a closely related species, black wattle (*Acacia mearnsii* De Wild) stated that, after large-scale fertiliser trials testing nitrogen, phosphorus, potassium, lime, and various trace elements, there was little to be gained by the use of fertilisers other than superphosphate.

The observed response of blackwood to pre-planting herbicide/spade cultivation demonstrates the degree of sensitivity of the species to weed competition. By age 2.7 years, both mean height and diameter growth in the maximum pre-plant treatment were superior to those in the minimum treatment. However, the large variation within treatments in this response negated statistical significance. The lack of a large and consistent response to pre-plant treatment suggests that blackwood may be relatively intermediate in its sensitivity to early weed competition. In this trial, young trees did not show the large responses to weed control generally seen in such sensitive species as eucalypts (Forest Research Institute 1982b; Schonau *et al.* 1981) and other hardwoods (Kennedy 1984) but appeared more sensitive than relatively tolerant species such as *Pinus radiata* (Messina unpubl. data). This observation concerning blackwood's relative sensitivity is further reinforced by the absence of a significant survival response to pre-planting treatment.

## CONCLUSIONS

General conclusions from this study are that:

(1) Blackwood at this site responded in early height and diameter growth to superphosphate applied within 2 months of planting;

(2) Pre-planting herbicide/spade cultivation can provide favourable growth response;

(3) Pre-planting treatment may improve survival slightly but fertiliser provides no survival advantages.

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