WEED INTERFERENCE IN TEA TREE PLANTATIONS

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Summary. Tea tree, *Melaleuca alternifolia*, is an annually-coppiced tree grown on the north coast of New South Wales for its leaf essential oil. In field experiments tea tree biomass yield did not always decline in the presence of weeds. This suggested that weed interference in the tea tree regrowth cycle is intermittent, and is dependent on interactions between the tea tree growth rate, harvest date, weed species present and soil moisture availability.

INTRODUCTION

The leaves of tea tree, *Melaleuca alternifolia*, contain an essential oil which is used as an antifungal agent, disinfectant or perfume. Tea tree occurs naturally in seasonally-waterlogged soils on the mid-eastern coast of Australia. Plantations have been established in the past 15 years for tea tree oil production. Trees are annually harvested to near-ground level, cut stumps then coppicing to commence a new shoot regrowth cycle.

In a 1992 survey approximately 80% of tea tree growers considered weeds to be a major limit to production, with a mean estimated regrowth biomass loss of approximately 45% if weeds are not controlled (Virtue and McMillan, unpublished data). Corresponding data on weed interference in other coppice systems to verify this estimate are negligible. It is difficult to compare coppicing tea tree with other tree crops due to the annual dramatic increase in the root:shoot ratio at harvest. This sudden change may impede root growth (2, 3) and make tea tree vulnerable to root competition from weeds. Shoot harvest to near-ground level may encourage weed interference, removing shade to promote weed germination and growth, and locating new tea tree shoot regrowth where it may have to compete with weeds for light. Alternatively tea tree may tolerate weed presence as coppicing trees can exhibit extremely vigorous early shoot growth (1).

This paper aims to quantify the effect of weed interference on tea tree biomass yield throughout the regrowth cycle.

METHODS

Sites. Experiments were conducted at three sites; Lismore, Ballina and Grafton. The Lismore site was a commercial plantation with trees in 4-row hedges (trees spaced 0.3x0.3 m) on raised beds 1.0 m apart. The Ballina site was a research plot with trees in single rows (trees spaced 0.25 m or 0.50 m within rows x 1.3 m between rows). The Grafton site was a commercial plantation with trees in 2-row hedges (trees spaced 0.30 m within rows x 0.50 between rows) on raised beds 0.80 m apart. All sites were on alluvial clay soils. Harvest dates were 6 February 1992 at Lismore, 5 February 1992 at Ballina and 16 April 1992 at Grafton.

Treatments and experimental design. All three sites had two basic treatments; no weeds present (NW) and weeds present (W). In the NW treatment weeds were mainly removed by hand-hoeing. In the W treatment weeds were allowed to grow unchecked throughout the experiment. Each treatment plot consisted of 20 trees for a certain sampling date. Sampling dates were 8, 15 and 57 weeks from harvest at Ballina, 13, 30 and 54 weeks from harvest at Grafton, and 8, 13, 19 and 50 weeks from harvest at Lismore. All experiments were randomised complete block designs with 3 replications at Ballina and 4 replications at Lismore and Grafton.

Sampling and measurement. At each sampling date the post-harvest coppice growth of 20 trees per plot was cut and bulked. Total shoot biomass was calculated from the product of the dry weight:fresh weight (DW:FW) ratio and the total FW. Leaf biomass was calculated from the product of the DW proportion of leaf and the total DW shoot biomass. Biomass yields (per 20 plants) were converted to yield/m^2 to enable comparisons between sites with different planting configurations, and to reduce the potential bias of different plot sizes due to missing trees. Weed samples were taken at each sampling date to measure weed shoot biomass/m^2. Five 0.1 m^2 strips of live weed shoot material were randomly taken, perpendicular to tree rows, and bulked.

Statistical analysis. Yield data were standardised via loge transformations, and analysed using ANOVA and 5%LSD. A sawfly (*Ptergophorous* sp.) larvae infestation at Ballina in April-May 1992 caused varying degrees of defoliation of many trees prior to the second sampling date. The raw leaf biomass data at the second sampling date were converted to a full leaf figure using a regression equation between DW leaf proportion and defoliation score. At the third sampling date regression analysis gave no strong relationship between individual plant FW and its former defoliation score, and thus the yield data was not adjusted.

RESULTS AND DISCUSSION

Yield data for Lismore are presented in Fig. 1. Total shoot biomass yields were only significantly reduced ($P<0.05$) in the W treatment at 13 and 19 weeks from harvest, by 32% and 34% respectively (relative to the NW treatment). Similarly leaf biomass yields were significantly reduced at these sampling dates; 32% at 13 weeks ($P<0.07$) and 33% at 19 weeks ($P<0.08$). Dominant weed species were cobbler's pegs, *Bidens pilosa*, tall fleabane, *Conyza albida*, nutgrasses, *Cyperus* spp., wandering Jew, *Commelina* spp., stagger weed, *Stachys arvensis*, and verbena, *Verbena* spp.

Yield data for Ballina are presented in Fig. 2. No significant differences in tea tree total shoot biomass or leaf biomass between the W and NW treatments were detected ($P<0.05$) at any sampling date. High variation inflated the limit of detection, this limit being a 60% total shoot biomass yield reduction (relative to the NW treatment) at 57 weeks. The weed flora was dominated by perennial grasses including setaria, *Setaria sphacelata*, paspalum, *Paspalum* spp., couch, *Cynodon dactylon*, and carpet grass, *Axonopus* spp.

Yield data for Grafton are presented in Fig. 3. Total shoot biomass yields were significantly reduced in the W treatment (relative to the NW treatment) by 28% at 13 weeks ($P<0.07$) and by 37% at 54 weeks from harvest ($P<0.05$). Leaf biomass yields were similarly significantly reduced ($P<0.05$) by 33% at both 13 and 54 weeks from harvest. Dominant weeds were spear thistle, *Cirsium vulgare*, pennywort, *Centella asiatica*, slender celery, *Apium leptophyllum*, common rush, *Juncus usitatus*, and grasses (summer grass, *Digitaria* spp., couch, paspalum and carpet grass).

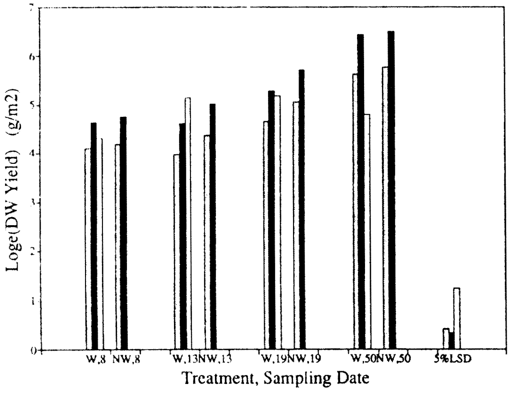

Figure 1. Lismore tea tree leaf biomass (grey bars), tea tree total shoot biomass (solid bars) and weed shoot biomass (empty bars) for the weeds present (W) and no weeds (NW) treatments at each sampling date.

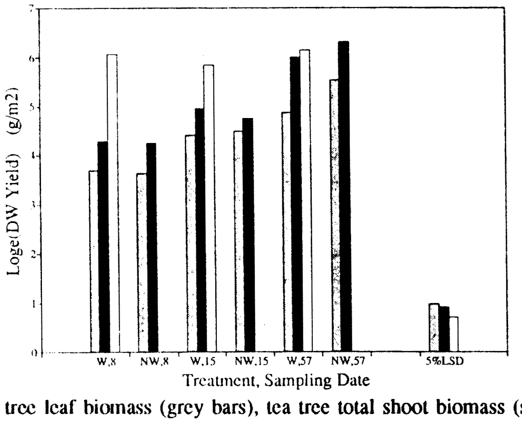

Figure 2. Ballina tea tree leaf biomass (grey bars), tea tree total shoot biomass (solid bars) and weed shoot biomass (empty bars) for the weeds present (W) and no weeds (NW) treatments at each sampling date.

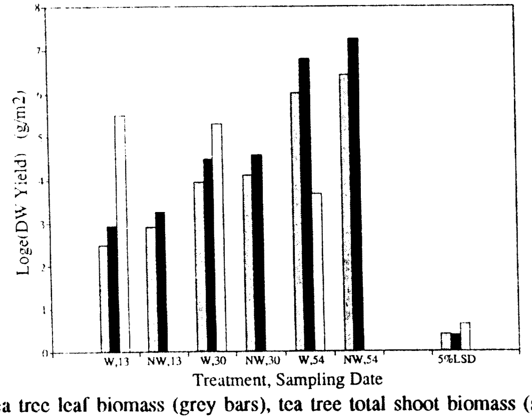

Figure 3. Grafton tea tree leaf biomass (grey bars), tea tree total shoot biomass (solid bars) and weed shoot biomass (empty bars) for the weeds present (W) and no weeds (NW) treatments at each sampling date.

The results show that weed interference can reduce biomass yields in tea tree, but such yield losses are intermittent and difficult to detect. Genetic variation (tea tree seed is collected from natural stands) was probably a major contributor to the detection problem. The extent of weed interference in tea tree plantations seems dependent on interactions between such factors as the tea tree growth rate, the harvest date, soil moisture availability and weed species present. Relative growth rates (data not given) to the first sampling dates at Lismore and Ballina were high (suggesting coppice vigour (1)), and trees grew well regardless of weed presence. Conversely at Grafton a late harvest date (with consequent lower temperatures) gave a slow growth rate to the first sample date, and may have made the trees susceptible to light competition from weeds. Light competition from weed species such as cobbler's pegs, wandering Jew and stagger weed may have reduced biomass yields at Lismore at the 13 and 19 week sampling dates. Soil moisture was readily available during the early regrowth at all three sites, and with probably high root:shoot ratios the tea tree would have obtained sufficient water and nutrients to not compete with weed root uptake. Root competition may have become more important as the trees grew larger, as at Grafton in late spring when a period of adequate soil moisture gave vigorous tree and weed growth. At Lismore during spring-summer and at Grafton during early spring soil moisture may have been so limiting that weed growth was poor and the W and NW treatment yields converged.

The only significant ($P<0.05$) final yield loss was 33% (in leaf biomass) at Grafton. This equates to a loss of $1176/ha (based on a measured oil concentration of 0.014 mL oil/g DW leaf, oil density of 0.89 g/mL and oil purchase price of $45/kg). At lismore and Ballina only large yield differences could be detected as statistically significant, but economically significant losses could still have occurred. If the observed differences in final mean yields between the W and NW treatments were infact losses due to weed interference, then these equated to $366/ha at Lismore (measured oil concentration 0.056 mL oil/g DW leaf). These figures certainly suggest that low cost weed control is profitable.

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