Physiological capacity of *Eucalyptus globulus*. Labill to recover following moderate defoliation

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Introduction

A major factor in economic viability of eucalypt in Tasmania, particularly *Eucalyptus globulus* Labill., is the impact of defoliation by herbivore.

To predict the impact of pest damage on plantation productivity, plant responses to pest attack must be considered. To do this, we investigated the effects of moderate defoliation on 13-metre trees of plantation *E.globulus*. This loss of leaf area may affect the tree's capacity for carbon assimilation by altering leaf photosynthesis, leaf nutrient and chemical contents, leaf diffusive conductance and tree water use.

The overall objective was to improve our capacity to model host responses to pest attack, by linking host physiological processes to resource availability. In particular we examined: What factors limit growth in defoliated and undefoliated trees? How does defoliation affect water use and water transport? Does defoliation alter foliar chemistry?

Figure 2. Photosynthetic measurement at 12 metres height.

Method

Six *E. globulus* trees were selected from an irrigated plot:
- Three trees were artificially defoliated in August 2006
- Three trees had no defoliation

For artificial defoliation, 45% of total tree leaf area was removed from the upper crown by excising all leaves except those at the branch tip to half crown height. Crowns of all trees were divided into three crown zones (Figure 1). An elevated work platform was used to access the tree crowns for measurements (Figure 2).

Photosynthesis, tree height, diameter at 1.3 m height, foliar nutrient (N and P) and chemical (chlorophyll, anthocyanin) contents, stomatal conductance (g_s) and water use were measured in each crown zone between 30 August 2006 and 29 March 2007.

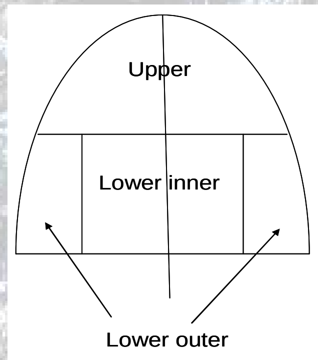

Figure 1. Crown zones used for measurements.

Results

Defoliation treatment had a **significant negative effect on diameter increment**, with a decrease of **57%** (P<0.05, Figure 3) by the end of experiment. Height increment was unaffected by defoliation (P>0.05).

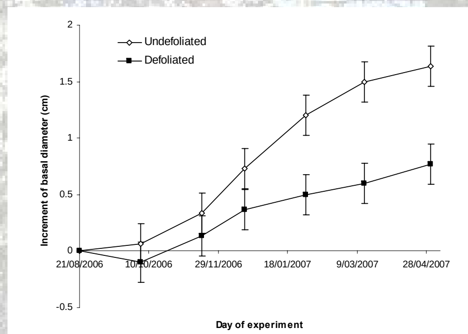

Figure 3. Mean increment of basal diameter growth over the period of the experiment. Error bar indicates standard error.

Within ~6 to 8 weeks, defoliated trees exhibited a **higher CO_2 assimilation (*A*)** than undefoliated trees (P<0.05, Figure 4). The **greatest upregulation of A occurred in the lower zones** from week 15 (P<0.05, Figure 4).

From week 21 after defoliation, ***A* was strongly related to g_s** (P<0.05), and the intercept was significantly **affected by defoliation** (P<0.05; Figure 5).

Total **leaf N** and **P** contents, **chlorophyll** and **anthocyanin were not affected** by treatment.

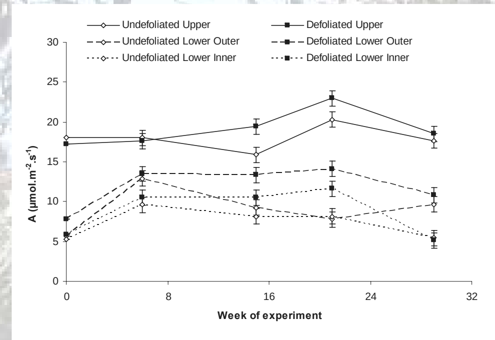

Figure 4. Net CO_2 assimilation (A) measured on one occasion before defoliation (week 0) and on four occasions after defoliation. Errors bars indicate standard errors.

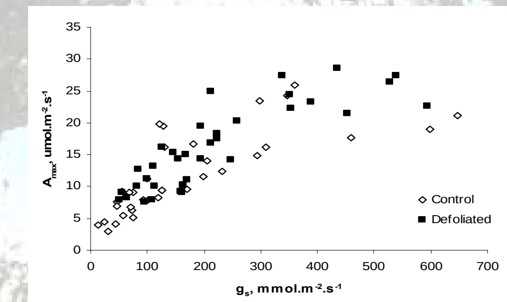

Figure 5. Net CO_2 assimilation (A) plotted against stomatal conductance (g_s) in undefoliated (open symbol, solid line) and defoliated (solid symbol, dotted line) E.globulus trees on 22/1/07.

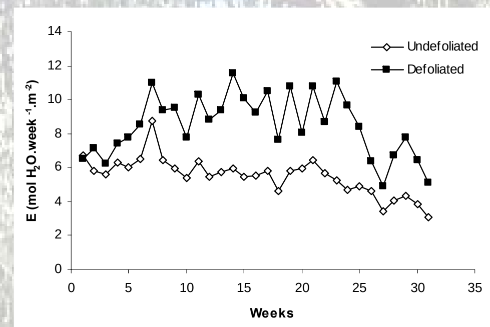

Figure 6. Weekly transpiration (E) of E.globulus subjected to defoliated and undefoliated treatments over the period of the experiment.

Throughout the time of the experiment the **weekly sum of tree transpiration per unit leaf area (*E*) increased** in defoliated (P<0.05, Figure 6) compared to undefoliated trees. *E* of defoliated trees was significantly related to vapour pressure deficit, *VPD* ($E_{defoliated}$ =4.09VPD+5.59, R^2=0.16, P<0.05).

Pre-dawn leaf water potential of defoliated trees was less negative and their **leaf hydraulic conductance (K_l) greater** than for undefoliated trees at all measurement times though these differences were not significant.

Conclusions

✓Defoliated trees were able to maintain height growth, at least for seven months. This suggests that *E.globulus* can tolerate occasional moderate defoliation without substantial loss of dominance. However, diameter growth was significantly reduced. This was similarly observed in a glasshouse experiment (Quentin *et al*. 2007).

✓*E.globulus* normally photosynthesises at rates below the potential maximum as illustrated by the enhancement of A following defoliation. Previous studies suggested that the size of this response was governed by the level of source limitation imposed by artificial defoliation (Pinkard *et al* 1998). Changes in g_s were important in governing A following defoliation (Figure 5). It is possible that stomatal density increases in leaves formed following partial defoliation, which may in part explain the increase in leaf conductance and transpiration.

✓Pre-dawn potentials of indicated a sufficient water supply throughout the investigation period (Breda *et al* 1995). Changes in transpiration and water use after defoliation were attributed to changes in climatic demand or physiological responses, or both (Medhurst *et al*. 2002).

References:

Breda *et al.* 1995. Effects of thinning on soil and tree water relations, transpiration and growth in oak forest (Quercus petraea (Matt). Liebl). Tree physiology 15: 295-306.

Medhurst *et al.* 2002. Measured and predicted changes in tree and stand water use following high-intensity thinning of 8-year-old *Euclyptus nitens* plantation. Tree Physiology 22: 775-784.

Pinkard *et al.* 1998. Photosynthetic responses of *Eucalyptus nitens* (Deane and Maiden) Maiden to green pruning. Trees 12: 119-129.

Quentin *et al.* 2007. Effects of artificial and leaf beetle (Coleoptera: *Chrysomelidae*) defoliation on photosynthesis, growth and biomass allocation of *Eucalyptus globulus* Labill. seedlings. (unpublished)