Effects of Cotton Defoliants on Native Trees in Cotton Production Areas of the Namoi Catchment at Boggabri, NSW, Australia: Field and Glasshouse Experiments

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CERTIFICATION

I certify that the substance of this thesis has not already been submitted for any degree and is not currently being submitted for any other degree or qualification.

I certify that any help received in preparing this thesis and all sources used, have been acknowledged in this thesis.

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ABSTRACT

Native tree decline and dieback are issues of general concern in many rural landscapes including cotton production regions of the Namoi Catchment in NSW, Australia. Landholders and cotton producers are interested in the potential effects of cotton defoliants on surrounding native trees via the mechanism of spray drift from cotton defoliation activities; whilst researchers, resource managers and sections of the wider community are keen to define all potential causal agents of the increasing frequency of tree loss in regions of north-western NSW. The aim of this research project was to determine the potential effects of cotton defoliants on localised Australian native tree species from north-western NSW and to assess potential of observed effects to contribute to native tree decline and dieback or act as causal agents of these conditions.

Five experiments (three field-based and two glasshouse-based) were designed to test the relative effects of four commercially-applied cotton defoliants (utilised in the Australian cotton industry), including: Dropp Liquid® (thidiazuron, TDZ), Dropp Ultra® (thidiazuron + diuron, TDZ+DN), Prep 720® (ethephon, ETP) and Atlacide® (sodium chlorate, $NaCl_3$). The two major field-based experiments examined the relative effects of annual and periodic exposure of young native trees to defoliants over three years, whilst the third measured the impact of an intentional over-spray during routine, commercial defoliation activities on mature trees (growing in a retained stand). The first glasshouse experiment involved the exposure of juvenile trees to a salt-based defoliant when combined with an oil-based surfactant and the second, the exposure of juvenile trees to key defoliants under different soil moisture regimes. The seven native tree species tested within the project were: *Acacia pendula* Cunn. Ex Don (myall), *Casuarina cristata* Miq. (belah), *Casuarina cunninghamiana* Miq. subsp. *cunninghamiana* (river she-oak), *Eucalyptus camaldulensis* Dehnh subsp. *camaldulensis* and *obtusa* (river red gum), *Eucalyptus melliodora* Cunn. Ex Schauer (yellow box), *Eucalyptus coolabah* Blakely & Jacobs, formerly *Eucalyptus microtheca* F. Muell (coolibah), and *Eucalyptus populnea* F. Muell. subsp. *bimbil*, L. Johnson & K. Hill (poplar box).

The highest application rate used was based on industry label recommendations for commercial cotton defoliation (the Standard rate) with lower rates representing one half and one quarter of that rate for each defoliant. Impacts on trees were measured by reductions in height growth, leaf defoliation, proportional leaf damage, apex damage, and the modification of new lateral shoot development. Significant responses were influenced by species, defoliant chemicals, application rates, time and the frequency of exposure. Key results from the major experiment investigating annual exposure were as follows: Atlacide® and Prep 720® resulted in the greatest significant

treatment effects; the Standard (highest) application rate caused the most effects per treatment; *C. cunninghamiana*, *E. camaldulensis* and *C. cristata* were the most affected tree species tested, and *A. pendula* was the least affected. An accumulation of impacts was also observed over time between all height, new lateral shoots and defoliation responses (plus a similar effect across all multiple response variables in two out of the three years of treatment exposure).

Key results from the experiment investigating periodic exposure included: an accumulation of effects for height and new lateral shoots responses from regular exposure; damage followed by recovery for defoliation, leaf and apex damage responses from periodic exposure, and evidence of some residual effects carried over between years. In the remaining three experiments, minor differences were observed for tree health, leaf health and crown condition of mature *E. populnea* trees in natural stands after exposure to defoliants in a commercial operation; the addition of the oil surfactant, Ampol® D-C-Tron oil did not enhance the effects of Atlacide® on juvenile trees, and the effects of experimentally increasing soil moisture stress did not act to enhance the effects of either Dropp Ultra® or Prep 720® on juvenile trees.

Major research findings were as follows: (a) the defoliants Atlacide®, Prep 720® and Dropp Ultra® adversely affected the health, growth and development of some native tree species over time, (b) Dropp Liquid® appeared to have the least affect or negligible effects on tree health, (c) species exhibited relative capacities to recover from the treatment effects, (d) treatments did not cause tree mortality, (e) *A. pendula* was the most tolerant species tested and would be suitable for using in buffer zone plantings, (f) defoliant effects could potentially be associated with the symptoms of dieback via the mechanisms of either off-target spray drift or over-spray, and (g) additional research is required to investigate: (i) longer term defoliant impacts, (ii) drift capture, (iii) mature tree impacts and (iv) tests of the relative tolerance and durability levels of other key native tree species, such as: *Corymbia tessellaris* K. Hill & L. Johnson, formerly *Eucalyptus tessellaris* F. Muell (carbeen), and *Eucalyptus pilligaensis* Maiden (Pilliga grey-box).