The effects of Cotton Defoliants on Native Trees

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Introduction

The application of cotton defoliants has on occasions been observed to effect the growth of native trees. Cotton growers need to know the potential effects of the defoliants on native trees in their local environment. They also need to know the implications of defoliant drift onto their spray drift buffer strips, which growers have spent many hours and dollars establishing on their farms. Spray drift from cotton defoliant chemicals has also been suggested as a potential causal agent of native tree dieback in the Liverpool Plains region of NSW and greater north-west NSW. Native tree dieback can be caused by many factors and the causal agents have not been effectively identified or justified, although many hypotheses have been formulated. Such causal theories include insect and bird attack, root pathogens such as *Phytophthora cinnamomi*, mistletoes, poor seedling recruitment, dryland salinity, grazing, old age, drought and waterlogging.

The primary aim of this study was to determine whether cotton defoliants affect native tree species common to north-west NSW and to quantify any impacts.

Methods

Cotton defoliants were applied to juveniles of eight native tree species common in north-west NSW and two varieties of cotton, under experimental conditions in a glasshouse trial at the University of New England, Armidale, NSW. The eight native tree species included Myall (*Acacia pendula*), Belah (*Casuarina cristata*), River She-Oak (*Casuarina cunninghamiana)*, White Box (*Eucalyptus albens*), River Red Gum (*Eucalyptus camaldulensis*), Yellow Box (*Eucalyptus melliodora*), Coolibah (*Eucalyptus microtheca*) and Poplar Box (*Eucalyptus populnea*). The two cotton varieties used were Sicala V-2 (broad leaf) and Siokra V16 (narrow, okra leaf). The four cotton defoliants applied in the experiment were Dropp 50 WP (Thidiazuron), Dropp Ultra (Thidiazuron plus Diuron), Prep 720 (Ethephon) and Leafex (Sodium Chloride).

The trial involved a completely randomised block experimental design with three replications, comprising seven defoliant treatments (including a no application control) using the four defoliants, with three defoliant application rates of, ½ of normal, normal and 1½ of normal. Treatments and application rates were developed in accordance with the defoliation combinations and rates used in commercial cotton production at given temperatures. Treatments were applied in two applications using a modified boom spray similar to those used in commercial cotton production, but on a smaller scale. Plant responses were measured over seven weeks (commencing from the first application) in terms of three main variables (1). Plant Growth, (2) Defoliation, and (3). Plant Damage. Plant growth was measured in terms of cumulative height increment (cm) and cumulative new lateral shoot development (no:). Defoliation was measured in terms of the amount of actual leaf loss from the upper, middle and lower crowns of each plant using indexes of leaf loss and mean scores for the whole plant. Plant dameage was measured in terms of leaf damage or leaf necrosis (indexes of leaf spot necrosis and leaf margin necrosis) and and damage to the apical growing shoot or tip of each plant (presence/absence).

All data were then tested for normality using the 'Wilk-Shapiro' test and separated into normally distributed data sets (i.e. parametric) and non-normally distributed data sets (i.e. non-parametric). All data sets were then statistically analysed with two-way and three-way Analysis of Variance (ANOVA) tests to highlight any statistically significant differences in treatment effects.

Results

As expected all six defoliation treatments effectively defoliated both the cotton varieties. The results also showed that some tree species were affected by various treatments with the *Casuarinas*, River She-Oak (*C. cunninghamiana*) and Belah (*C. cristata*) and the *Eucalypt*, River Red Gum (*E. camaldulenis*) being the most affected species. The two *Casuarinas* suffered significant increases in defoliation and leaf damage as well as reduced height increment. River Red Gum incurred significant increases in lateral shoot development, defoliation, leaf and apical shoot damage as well as reduced height increment. Results also showed that the most tolerant or unaffected native tree species was Myall (*Acacia pendula*) as it showed no significant effects from any defoliant or treatment.

Figure 1. shows that treatments 2 (Dropp U x Dropp U) and 5 (Dropp U x Prep) caused highly significant ($P<0.01$) differences, or decreases in height increment for River She-Oak. Figure 1. also shows that treatments 6 (Leafex x Leafex) and 7 (Control, no defoliant) caused non-significant ($P>0.05$) differences in height increment for River She-Oak. Figure 2. shows that treatments 2 (Dropp U x Dropp U), 5 (Dropp U x Prep) and 4 (Dropp WP x Prep) caused highly significant ($P<0.01$) differences, or decreases in height increment for Belah. Figure 2. also shows that treatments 7 (Control) and 6 (Leafex x Leafex) caused non-significant differences ($P>0.05$) differences in height increment for River She-Oak. Figure 3. shows that treatments 5 (Dropp U x Prep) and 3 (Prep x Prep) caused highly significant ($P<0.01$) differences, or decreases in height increment for River Red Gum, while treatment 7 (Control) caused non-significant differences ($P>0.05$) in height increment.

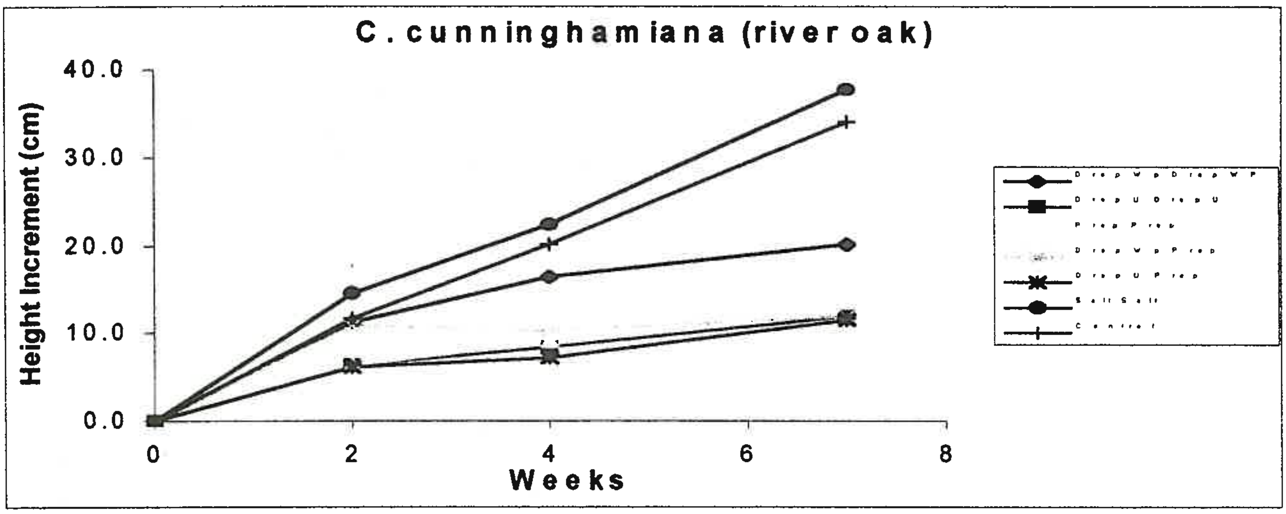

Figure 1. Cumulative mean height increments for *C. cunninghamiana* by treatments over time.

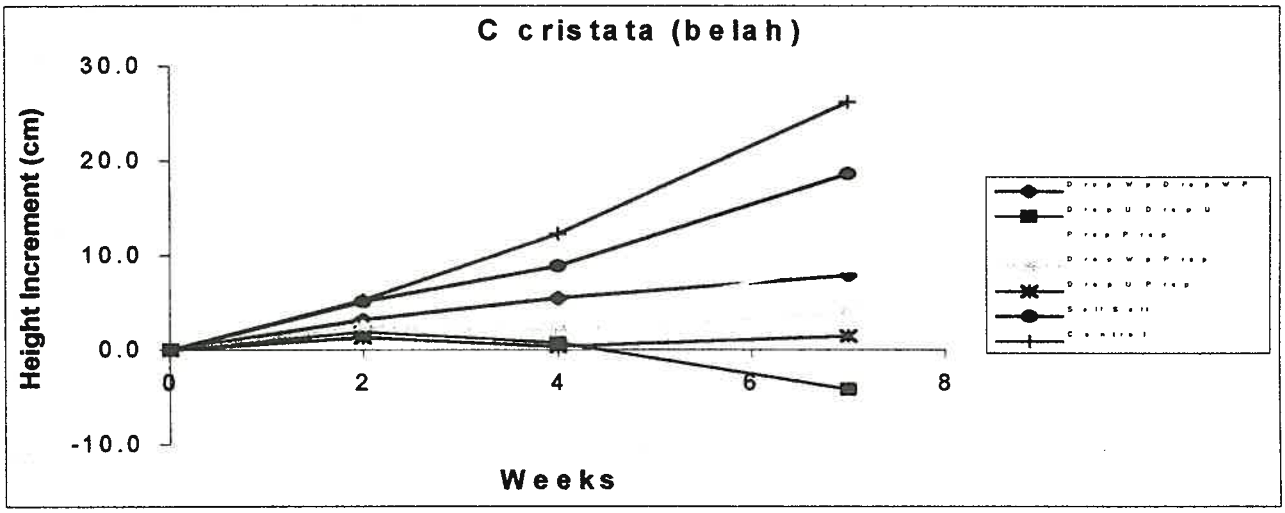

Figure 2. Cumulative mean height increments for *C. cristata* by treatments over time.

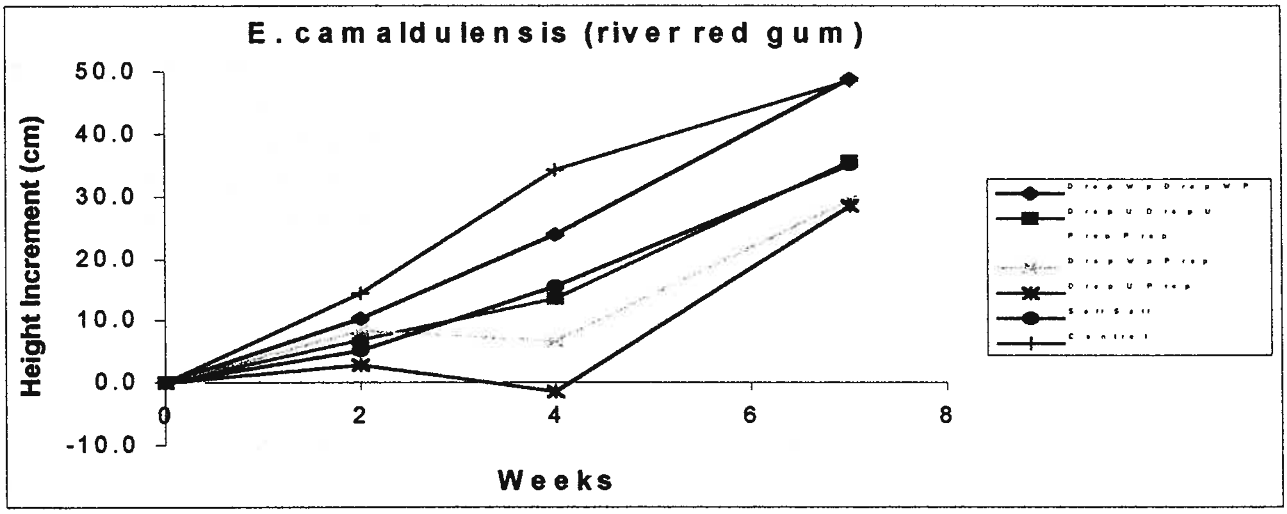

Figure 3. Cumulative mean height increment for *E. camaldulensis* by treatments over time.

Results also showed that treatments 3 (Prep x Prep), 5 (Dropp U x Prep) and 2 (Dropp U x Dropp U) caused the most significant effects overall. Treatment 6 (Leafex x Leafex) caused significant leaf damage to specific tree species, such as the *Eucalypt* White Box (*E. albens*). The results also showed that affected plants showed some recovery, meaning that plants did not die as a result of the defoliant effect.

Discussion

The fact that the *Casuarina* species were the most affected by the defoliant treatments may be explained by their physiology and leaf shape. Trees with small, needle-like leaves (ie. branchlets) such as casuarinas are more effective and efficient at intercepting spray drift droplets from liquids and gases in the air than trees with larger, broader, and smoother leaves, such as eucalypts (NSWAG 1998; Aitchison 1999). Aitchison (1999) explains this theory by stating that the smaller the catching surface of the leaf, the less air deviates around the object, increasing the probability of intercepting small droplets. This phenomenon relates to the surface area to volume ratio of leaves, for which the branchlets of casuarinas have less surface area and more volume than most eucalypts. This theory is made more relevant because all native tree species suffered significantly higher levels of defoliation and leaf damage under the high application rate (ie. rate 3), meaning that the *Casuarinas* should have suffered more damage if they intercepted more defoliant. It is known that better cotton defoliation results with higher application rates (Hake *et al.* 1990; CCRC 1999).

The fact that the defoliants Dropp Ultra and Prep and treatments with combinations of these defoliants, such as treatments 2 (Dropp U x Dropp U), 3 (Prep x Prep) and 5 (Dropp U x Prep) caused the most effect may be explained by their active chemical constituents. Prep contains the active chemical constituent Ethephon, which stimulates the production of the chemical hormone ethylene in plants, particularly in cotton, which is one of the most effective stimulants for the formation of an abscission layer or zone, which causes leaf defoliation through leaf abscission (CCRC 1999; Cothren 1994). Dropp Ultra contains the chemical constituents Thidiazuron plus Diuron, which is a registered herbicide which is a possible reason for this trend in the results.

Future Research

It is acknowledged these are the results of one experiment, thus it is planned to repeat this experiment under "field conditions" at two locations in the Namoi Valley during the consecutive 2001 and 2002 cotton defoliation seasons. A fully replicated experiment using a range of tree species will be planted this spring (September 2000). Some experimental work will also be conducted on some mature aged trees. Once this work has been completed more definite conclusions should be possible.

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