Phosphite application as an explorative tool for understanding and controlling *Eucalyptus gomphocephala* (tuart) decline in southwest Western Australia

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Introduction

Eucalyptus gomphocephala (tuart) is a Mediterranean key stone forest canopy species endemic to a narrow (5-10 km wide) coastal strip approximately 300 km in length in southwest Western Australia. The tuart is undergoing a significant decline that was first identified as a spot decline in 1991 and now occurs throughout large sections of its remnant distribution within Yalgorup National Park. The potential of phosphite (phosphonate), nutrient and insecticide treatments to reverse the decline in tree health was assessed as (a) a method for controlling the decline and (b) a method for diagnosing possible causal agents. Phosphite has been successfully used to control *Phytophthora* and Pythiaceous soil-borne plant pathogens by inducing a host defense response, inhibiting disease at concentrations only partially inhibitory to pathogen growth *in vitro* (Guest and Bompeix 1990). Recovery of declining tuart after phosphite application supports the possible role of these Pythiaceous organisms in the decline. The aim of this study was to determine the impact of nutrient, insecticide and phosphite application on the canopy condition of declining tuart, and to determine if Pythiaceous organisms are associated with the decline.

Materials and Methods

Experiment 1. The independent variables were the assessed trees and stem injection applications including three phosphite application concentrations, three nutrient amendments and an insecticide treatment. Phosphite was applied as mono-di potassium phosphite [Folir-R-fos 400 (UIM Agrochemicals Pty Ltd), a 40% solution neutralized to a pH of 6.7.] at application rates of 0, 25, 50 and 75 mg per cm circumference at 1.5 m from ground level. The three nutrient treatments included zinc (MEDICAP® ZN), iron (MEDICAP® FE), and complete nutrient (MEDICAP® MD; iron, manganese, zinc, total nitrogen, phosphoric acid and soluble potash). Insecticide treatment consisted of ACECAP 97® systemic insecticide containing active ingredient Orthene®. The treatments were applied to 48 trees in a cross classified design (Gad 2005) between the 4th and 8th of April 2005. Dependent variables included crown condition measured every six months after treatment and treatment toxicity measured six months after treatment. Crown condition was determined using a modified version of the crown assessment method of Grimes (1978) and using photographic assessment.

Experiment 2. The independent variables included the assessed tuart trees and six phosphite treatments of 0, 75, 150, 225, 300 and 375 mg per cm circumference at 1.5 m from ground level. Ten replicates of each treatment were applied in a randomised block design at the end of summer on the 30th January 2005. Dependent variables included: crown condition measured every three months after treatment application; foliar phosphite concentration and phytotoxicity measured four weeks after treatment; and leaf nutrient concentration measured four weeks and 18 months after treatment.

Results

Experiment 1. An ANOVA analysis of the combined effect of phosphite, nutrient and insecticide treatments indicates that phosphite, nutrient and phosphite combined with nutrient application resulted in a significant ($p<0.05$) improvement in crown condition over time (Figure 1). Phosphite, nutrient and insecticide treatments alone or insecticide treatment in combination with other treatments did not significantly ($P>0.05$) improve crown condition.

Experiment 2. Trees treated with 150 mg phosphite had the most improved canopy condition followed by 225 mg applications (Figure 2). Control trees not treated with phosphite had the greatest decrease in canopy condition followed by trees treated with 375mg/cm phosphite. Significant ($P<0.05$) variation was observed in the crown condition of phosphite treated trees one year after application.

Discussion

Phosphite and nutrient application improved the crown condition of declining trees. The individual phosphite and nutrient treatments may have a significant effect on the crown condition of declining trees, although there was possibly insufficient replication within the experiment to emphasize these specific effects. These findings indicate that phosphite and nutrient application may be an effective management tool for the rehabilitation of declining tuart. The phosphite and nutrient treatments applied to declining trees may beneficially impact on the disease syndrome that has been resulting in decline. The applied nutrient amendments are all involved in biochemical processes crucial to plant growth and maintenance in

Eucalyptus (Dell 1996). These nutrient amendments may therefore have corrected any nutrient imbalance irrespective of the cause. Further research into the application of nutrient amendments is currently underway (Barber 2007). In experiment 2, phosphite application improved canopy condition at application rates of 150, 225 and 300 mg, and slowed the decline in crown condition at rates of 75 and 375 mg. Variation in the change of canopy condition of the non-treated control trees suggest variations in site and seasonal influences. The data strongly suggests a tolerance curve indicating that applications below 150 mg per cm are insufficient and application above 150 mg may have deleterious side effects suggesting decreased activity due to phytotoxicity, as confirmed by observed foliar burns. A *Phytophthora* species has recently been identified in declining trees, further supporting the observation that phosphite treatment helps to reverse the decline syndrome.

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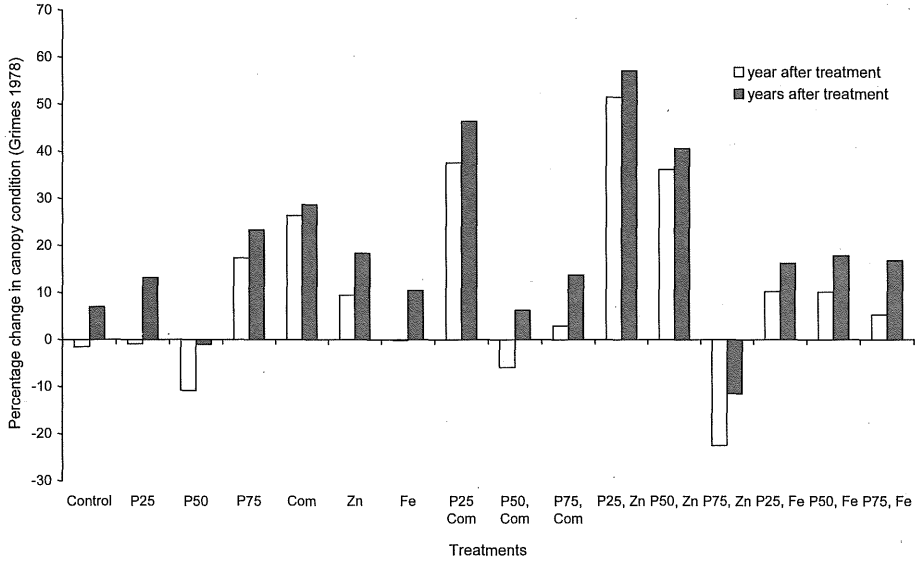

Figure 1. Percentage change in crown condition (Grimes, 1978) after phosphite, nutrient and combined phosphite and nutrient applications. P25, P50, P75 and Pcon correspond to phosphite application at 25, 50, 75 and 0 mg per cm circumference. Zn, Fe, Com and Ncon correspond to Zinc, Iron, complete and nutrient application control.

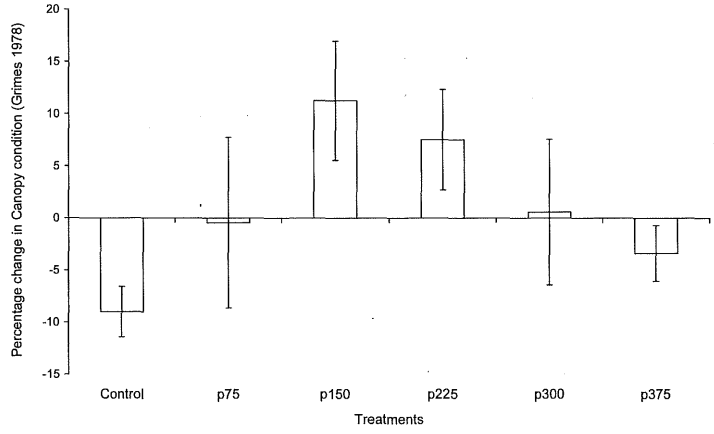

Figure 2. Percentage change in canopy condition (Grimes 1978) 1 year after phosphite application at O (control), 75, 150, 225, 300 and 375 mg per cm circumference as indicated.