PROJECT 1

THE CONTROL OF *PHYTOPHTHORA* IN NATIVE PLANT COMMUNITIES

PART C

APPLICATIONS OF PHOSPHONATE IN THE SOUTH COAST REGION

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1 INTRODUCTION

Komorek *et al.* (1995) have developed aerial application techniques for spraying whole plant communities with phosphonate, either in areas currently infected by *Phytophthora cinnamomi* (particularly localised infections) or along a dieback front to protect healthy vegetation. Thus, phosphonate application can become an important element of an integrated control strategy.

Research has been conducted to identify application rates which ultimately result in concentrations of the active ingredient (phosphite) in plant tissues that effectively control the pathogen over the greatest time frame without compromising plant health. Phosphonate applied at 20% - 40% at a rate of 60λ ha^{-1} in two sprays resulted in phosphite concentrations expected to ensure long term infection control (Komorek *et al* (1995). The application of 40% phosphonate resulted in a significantly greater concentration of phosphite in plant tissue than did applications of less concentrated sprays (B. Komorek pers. comm.).

While phosphonate is considered to have low toxicity (Guest & Grant, 1991) evidence of phytotoxicity has been reported in a range of horticultural species Seymour *et al.*, 1994; Walker, 1989; Wicks & Hall, 1990). Symptoms of phytotoxicity include marginal to complete leaf burn, leaf shedding and mutation of leaf tips. Following recent phosphonate trials, phytotoxicity has also been recorded in a small number of native species (Komorek *et al.*, 1995; Bennalick, 1995). However, most research has been focussed on *Banksia* spp. and *Eucalyptus marginata*. Individual species may vary in their response and subsequent recovery to phytotoxicity associated with phosphonate treatment (Bennalick, 1985). The effects induced by broad-scale application of a given concentration of phosphonate are unknown at the species, genus or family levels. It is therefore necessary to investigate the effect of phosphonate on a broad range of species before using the fungicide more widely.

While phosphonate has been found to increase the resistance of several native species to *P. cinnamomi,* it is unclear whether the chemical can eradicate the pathogen from infected areas or even minimise its' spread from spot infections.

2 OBJECTIVES

The major objectives of this work are:

- To assess the sensitivity of plant species in selected communities on the south coast of Western Australia to foliar application of phosphonate and to examine the effects of the chemical on plant growth and reproduction.

- To assess the ability of phosphonate to increase the resistance of plant communities to infection by *P. cinnamomi* by aerial spraying and subsequent monitoring of an infection in the Fitzgerald River National Park, and by monitoring post aerial spray of dieback-infected vegetation on Bluff Knoll, Stirling Range National Park.

3 EXPECTED OUTCOMES

- Data obtained from assessment of relative sensitivity of plant species to phosphonate should provide a guide for prediction of plant responses in other situations when phosphonate spraying is proposed. It should also provide guidelines for selection of appropriate spraying regimes. Information on plant recovery, plant vigour and potential effects on plant reproduction is necessary to ensure that species viability is not compromised by phosphonate application.

- Monitoring the survival of susceptible species and movement of the dieback front following an operational spray in the Bell Track area, Fitzgerald River National Park, will provide data on the effectiveness of phosphonate in controlling the spread of *P. cinnamomi*. Similarly, monitoring of survival rates in susceptible species in a critically endangered plant community on Bluff Knoll, Stirling Range National Park, after a second operational spray will provide data on the effectiveness of phosphonate for controlling *P. cinnamomi* in infected vegetation.

4 METHODS

4.1 BACKGROUND

The project, which commenced in October 1996, has two components:

- Research trials using a range of application rates to assess plant community responses to phosphonate at the species level.

- Operational spray of the Bell Track *Phytophthora* infection in the Fitzgerald River National Park and subsequent monitoring of disease impact. Monitoring of Bluff Knoll post-operational spray.

4.2 RESEARCH TRIALS

The research trials consist of two components:

- Trials using phosphonate concentrations and application rates based on results of recent work by Komorek *et al* (1995). These include both aerial applications (Bell Track, Fitzgerald River National Park) and hand-spray applications (Bluff Knoll, Stirling Range National Park; Gull Rock National Park).

- Hand-spray trials to compare plant sensitivity between species at high application rates selected to incur mild, moderate and severe phytotoxicity (Gull Rock National Park; Kamballup Nature Reserve).

4.2.1 Trials Using Phosphonate Applications Based on Komorek *et al* (1995).

4.2.1.1 Establishment of Monitoring Plots

Monitoring quadrats were established for the Bluff Knoll and Gull Rock hand-spray trials using plots 1 m x 5 m. Plot size was selected to ensure that a representative sample of the plant community was assessed in each quadrat. Six quadrats and sampling plots were established for each treatment including the control. In all quadrats, the average percentage canopy cover of each species was recorded together with the mean canopy cover of diseased or necrotic foliage present before spraying.

For the aerial application trials at Bell Track, Fitzgerald River National Park, six, 5m x 5 m quadrats were established per treatment and data were recorded as for the hand-spray trials. Plots were located in dieback-free vegetation at the Bell Track and Gull Rock sites and within dieback-infected vegetation on Bluff Knoll.

4.2.1.2 Phosphonate Application

Phosphonate was applied to the treatment plots in each plant community at three different rates including 24, 36 and 48 Kg of active ingredient per hectare. The 24 Kg ha^{-1} and 48 Kg ha^{-1} applications utilised 40% phosphonate (Foli-R-fos 400) applied at rates of 30 and 60λ ha^{-1} respectively while the intermediate level utilised 30% phosphonate applied at 60λ ha^{-1}. Synertrol, a vegetable oil concentrate, was added to all sprays as a surfactant at the rate of 2%. Synertrol maximises phosphonate uptake by assisting the formation of uniformly sized spray droplets, increasing droplet deposition and spread, and by reducing evaporation or removal by rainfall.

The Bell Track communities were aerially sprayed by Giles Aviation while the other communities were sprayed using the Microfit Herbi, a lightweight hand-held sprayer which permits ultra-low-volume application. The sprayer is designed to apply chemical in a controlled droplet range around 0.25mm along a path of about 1.2m wide. The controlled droplets facilitate even distribution and minimise drift. The sprayer was adjusted to provide delivery of 30λ ha^{-1} at a walking speed of 1m sec^{-1}. Oil sensitive test paper was used to assess droplet size and density. Spraying was conducted in wind speed conditions of less than 10 knots to minimise spray drift. Spraying of all trials was conducted between early and mid-morning at temperatures less than 30^{0}C.

4.2.1.3 Post-spray Assessment

Two weeks after spraying, all plots were assessed for signs of phytotoxicity and the average percentage canopy cover of damaged foliage was recorded for affected species. Control plots were assessed for changes in plant health. Species were selected for phosphite analyses and monitoring of plant growth, phytotoxicity, plant recovery, plant reproduction, and survival of dieback-susceptible taxa where applicable.

4.2.2 Hand-spray Trials Comparing Plant Sensitivity to Phosphonate at High Application Rates.

4.2.2.1 Establishment of Plots and Phosphonate Application

A second series of hand-spray trials was conducted at two sites (Gull Rock National Park and Kamballup Nature Reserve) using application rates selected to induce mild, moderate or severe phytotoxicity in order to assess the relative sensitivity of species, genera or families to phosphonate. Other features of the trials included assessments of plant recovery from phytotoxicity, plant growth and effects of phosphonate on flowering, fruiting and seeding.
Three application rates were selected following a trial of six concentrations and subsequent observations of phytotoxicity in *Agonis hypericifolia*, a species which demonstrated sensitivity in the previous trials at Gull Rock. Monitoring plots were established and assessed at both sites as for other hand-spray trials. Phosphonate was applied at 36, 72 and 144 Kg ha^{-1} using 40% phosphonate.

4.2.2.2 Post-spray Monitoring

All species were assessed for phytotoxicity and the average percentage canopy cover of damaged foliage was recorded two weeks after spraying and again, five weeks later. Four susceptible species (15 plants/species) were tagged for assessment of canopy cover, phytotoxicity and subsequent recovery. At the Gull Rock site, *Banksia coccinea* (15 plants) was tagged and measurements of height were recorded. Samples were also collected (20/treatment) from plants showing either high, slight or variable degrees of sensitivity to phosphonate with each sensitivity class represented by two species.

4.3 OPERATIONAL SPRAY AND MONITORING.

4.3.1 Bell Track

Monitoring plots were established on either side of the dieback front in two affected plant communities. Six 5 m x 5 m plots were established within dieback-affected vegetation behind the front, and four 5 m x 5 m plots were located in healthy vegetation on the dieback front. A rate of spread trial was established in both communities using steel droppers placed at 2.5 m intervals. Control plots were established using the same methodology. Following assessment of any phytotoxicity induced by the three trial concentrations, and determination of phosphite levels in plant tissues, an appropriate application will be selected for the operational spray in March 1997.

4.3.2 Post- spray Monitoring

On the date of spraying, key dieback-sensitive species will be counted in both dieback-affected and unaffected plots. Post-spray, all species will subsequently be assessed for signs of phytotoxicity, and appropriate species will be selected for phosphite analyses.

5 PRELIMINARY RESULTS AND DISCUSSION

Monitoring plots have been established for both operational and research trials. Spraying of all research trials has been completed and two post-spray assessments of plant health have been undertaken at these sites.

5.1 PHYTOTOXICITY

Sensitivity to phosphonate was observed in plants from the genera *Eucalyptus, Agonis, Astartea, Baeckea, Calytrix, Leptospermum, Melaleuca, Hypocalymma* (Myrtaceae); *Lysinema* (Epacridaceae); *Dasypogon* (Dasypogonaceae) *Goodenia* (Goodeniaceae) *Conospermum, Hakea, Isopogon* and *Petrophile* (Proteaceae); *Daviesia* and *Jacksonia* (Papilionaceae); *Acacia* (Mimosaceae); *Anarthria* (Restionaceae) *Boronia* (Rutaceae) and *Xanthorrhoea* (Xanthorrhoeaceae).

Leaf tip necrosis was the most common sign of damage induced by phosphonate. Increasing phytotoxicity was manifested by extension of the necrotic area to leaf margins and then to the entire leaf. Patchy necrosis was observed in larger-leafed species. Where whole leaf necrosis occurred, dehiscence of leaves was observed in some species. In general the symptoms appeared consistent with localised chemical burning. Damage to flowers and discolouration of fruits was observed at the greater rates of phosphonate application. Exudation of fluid was observed on leaves of *Eucalyptus* spp. at the Kamballup site and salts had accumulated on leaf surfaces there.

In sensitive species phytotoxicity associated with application of phosphonate resulted in mild (<20%) to moderate (20-40%) leaf damage at the lower rates (24 and 36 Kg ha^{-1}), with greater necrosis (40-60%) noted for particular species treated with 48 Kg ha^{-1}. Moderate to severe (>60%) necrosis was observed in some sensitive species at the higher application rates (36, 72 & 144 Kg ha^{-1}). However, even at the greatest rate non-sensitive species displayed only minimal damage. Considerable variation in the severity of damage between individual plants was observed in some species.

5.2 PLANT REPRODUCTION

Assessment of fruiting in the obligate seeder species *Jacksonia spinosa* and *Lysinema ciliatum* was undertaken at the Gull Rock site. In *Jacksonia*, production of mature fruit was reduced by treatment with phosphonate at all test concentrations, with the most severe effect noted for the greater rates of application. In *Lysinema* fruiting was reduced only at the highest application rate. However, seed numbers released from mature fruits were reduced by application at 72 or 144 Kg ha^{-1}. It is possible that the influence of phosphonate on fruiting may be associated with short-term effects on flowering.

Seed has not yet been assessed for viability and the results of phosphite analyses are currently unavailable.

6 PROPOSED MONITORING

- Re-assessment of sprayed plots (Bell Track , Gull Rock, Kamballup, Bluff Knoll) to monitor plant health in autumn (March 1997), early winter (June 1997), spring (October 1997) and April 1998. Assess fruiting, seeding, and plant growth in appropriate species. Sample foliage for phosphite analyses in May, June and October 1997, and at six-monthly intervals thereafter.

- In April and May, 1997, assessment of plots (post-operational spray) for phytotoxicity at both plant communities on the Bell Track. Also collection of samples for phosphite analyses.

- Establishment of plots (post-operational spray) at Bluff Knoll, Stirling Range National Park in April/ May 1997. Assess same for phytotoxicity and collect samples for phosphite analyses. Estimate numbers of key, dieback-susceptible species in monitoring quadrats and control quadrats on the date of spraying.

- Operational sprays: reassess monitoring quadrats and rate of spread trials and collect samples for phosphite analyses in October 1997 and at six monthly intervals thereafter.

7 REFERENCES

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CONTROL OF *PHYTOPHTHORA* AND *DIPLODINA* CANKER IN WESTERN AUSTRALIA

FINAL REPORT

TO THE THREATENED SPECIES AND COMMUNITIES UNIT, BIODIVERSITY GROUP ENVIRONMENT AUSTRALIA

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