Injected Treatments for Management of Madrone Canker

Marianne Elliott and Robert L. Edmonds

Abstract. Pacific madrone (Arbutus menziesii) has been experiencing a decline in the Puget Sound area, primarily as a result of a canker disease caused by the fungus Fusicoccum arbuti. Cultural methods such as prevention of stress and wounding are recommended to control canker diseases on trees. In addition to these, injected treatments can be used to protect valuable Pacific madrone trees in urban areas. An experiment testing injectable chemical fungicides and plant activators was performed on Pacific madrone trees inoculated with F. arbuti. There was little correlation between fungicidal activity in culture and canker reduction in the field tests. Two treatments that were effective in minimizing canker growth in inoculated madrones were Arbotect® (Syngenta Crop Protection Inc., Greensboro, NC, U.S.: a triazole fungicide) and BioSerum™ (phosphorous acid). Cankers on wound inoculations were 50% smaller than the control group and no infections occurred on surface-inoculated treatments. Increased callusing was observed on cankers on trees with these treatments and the mode of action for these chemicals is probably plant defense responses rather than fungicidal action. Phosphorous acid is recommended in addition to cultural methods that improve tree vigor for high-value madrone trees in urban landscapes; however, heavily infected trees that have lost most of their crown will probably not benefit.

Key Words. Arbotect®; Botryosphaeria; canker; Fusicoccum; injectible fungicide; Pacific madrone (Arbutus menziesii); phosphorous acid; plant activator.
der pressure, and infusion, in which a large volume of dilute solution is fed into the tree through gravity and taken up in the transpiration stream. Treatments should be performed on a day when the tree is actively transpiring and after a period of heavy rainfall for best results (Stipes 1988). These methods do not eradicate the pathogenic fungus, but reduce symptom expression and inoculum density so that the tree can be healthy enough to defend itself. Injected fungicide or plant activator treatments in combination with cultural methods to improve tree vigor have the most likelihood of success. Injection treatments on DED are advised when there is no more than 5% to 10% of the crown affected by disease. In general, injection treatments are not recommended for trees with severe disease symptoms (Lanier 1988). Trees of reduced vigor are less likely to recover from injuries sustained during injection. There are no reports of injected treatments being used to manage Botryosphaeria diseases on trees.

The best treatments for madrone canker are ones that will improve overall tree vigor and include cultural methods such as sanitation, prevention of wounding, and improving soil water retention. Additional protection can be used in the form of chemical treatments, especially on high-value trees. Systemic fungicides and plant activators will give additional disease resistance, but are costly and can be damaging in some situations.

The objective of this study was to evaluate the ability of several injected chemicals to reduce damage to Pacific madrone caused by the canker pathogen *F. arbuti*.

**METHODS**

### In Vitro Testing of Fungicides

Eighteen fungicides and plant activators were tested for efficacy against *F. arbuti* in culture (see Table 1 for list; mode of action is indicated). Two hundred parts per million active ingredient of each chemical was added to 2% malt extract agar. Controls were plates with 2% malt extract agar and no added chemical. Nine isolates of *F. arbuti* collected from the range of Pacific madrone, from southern California to Washington State, were tested using three replicates of each fungal isolate. Plates were inoculated from plugs taken from active cultures and incubated at 25°C (77°F; the optimal temperature for *F. arbuti* radial growth) and fungal radial growth was measured at intervals of 7 days for 1 month and expressed as millimeters per day.

### Field Tests of Systemic Treatments

The field tests took place on Lopez Island, Washington. Forests in this region are drier than those on the mainland as a result of the influence of the Olympic Mountains and Vancouver Island situated southwest and west northwest of the San Juan Islands. These land masses create a “rain shadow” effect that produces less rainfall in the islands than the rest of northern Puget Sound. At the nearest weather station at Olga on Orcas Island, the average high temperature in July is 21°C (69.8°F), and the average low in January is 2°C (35.6°F) (WRCC 2006). Winter temperatures are usually mild, except when cold, arctic air funnels down the Fraser River Valley from Canada and drastically lowers temperatures. Winds may also have a drying effect, pulling moisture from vegetation and surface water, and creating drought stress during low rainfall periods.

One hundred twenty-eight Pacific madrone trees were selected for field tests of the chemical treatments. These trees were located in a forested area with Douglas fir (*Pseudotsuga menziesii*) canopy dominants. The madrones formed a layer under the Douglas fir and many showed signs of competition for space and light. Most of the trees were intermediate or suppressed crown classes and growing at the edge or interior of the stand. The stand was considered to be intermediate in moisture conditions between dry and moist woodland. Soils are deeper on this site (San Juan County Health and Community Services 2000) than in other areas of the San Juan Islands and have a thick duff layer. Typical shrubs were salal (*Gaultheria shallon*), Oregon grape (*Holonia opulifolia*), and salal (*Gaultheria shallon*).
Port Townsend, Washington. This isolate was chosen because it
was selected for use in mycelial growth in vitro, but BioSerum
™ was selected for the field tests were Alamo, Arbotect, and a water control (see list in
Table 1). These chemicals were selected based on their behavior
on stressed trees and any treatment that was successful on them
could have a good possibility of being effective on urban trees
taking into account environmental factors that may influence
disease development.
Each tree was evaluated and data were collected on diameter
at breast height (dbh) and percent dieback, crown, and live foli-
(€Mahonia nervosa), ocean spray (Holodiscus discolor), and little wild rose ( Rosa gymnocarpa).
M any of the trees in the stand were infected with F. arbuti in
varying degrees of severity. Lopez Island is in an area severely
affected by Pacific madrone decline (USFS 2003) and cankers
on some trees were at least 15 years old as estimated by the
number of callus layers. These trees on Lopez Island were good
candidates for treatment because Fusicoccum is more aggressive
on stressed trees and any treatment that was successful on them
might have a good possibility of being effective on urban trees
taking into account environmental factors that may influence
disease development.

Table 3. Percent inhibition of mycelia growth of nine isolates of Fusicoccum arbuti from Washington and California in culture
with 200 ppm fungicide.\textsuperscript{a}

<table>
<thead>
<tr>
<th>Isolate</th>
<th>Actigard</th>
<th>Bayleton</th>
<th>Compass</th>
<th>Kaligreen</th>
<th>Nucop</th>
<th>Subdue Maxx</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. King Co., WA</td>
<td>44.8 ab</td>
<td>82 c</td>
<td>50.2 ab</td>
<td>−5.1 ab</td>
<td>78.4 ab</td>
<td>3.8 ab</td>
</tr>
<tr>
<td>2. King Co., WA</td>
<td>51.1 ab</td>
<td>nt</td>
<td>45.7 ab</td>
<td>22.6 c</td>
<td>80.0 ab</td>
<td>2.2 ab</td>
</tr>
<tr>
<td>3. King Co., WA</td>
<td>54.8 b</td>
<td>100 d</td>
<td>64.8 b</td>
<td>15.4 abc</td>
<td>86.9 b</td>
<td>15.1 b</td>
</tr>
<tr>
<td>4. Vashon, WA</td>
<td>27.8 a</td>
<td>78.9 bc</td>
<td>47.5 ab</td>
<td>18.9 bc</td>
<td>75.8 ab</td>
<td>8.0 ab</td>
</tr>
<tr>
<td>5. Vashon, WA</td>
<td>45.9 ab</td>
<td>77.9 b</td>
<td>40.2 a</td>
<td>15.5 abc</td>
<td>75.6 ab</td>
<td>0.7 ab</td>
</tr>
<tr>
<td>6. Trinity Co., CA</td>
<td>42.6 ab</td>
<td>100 d</td>
<td>50.9 ab</td>
<td>−1.4 ab</td>
<td>76.7 ab</td>
<td>4.3 ab</td>
</tr>
<tr>
<td>7. Nevada Co., CA</td>
<td>50.1 ab</td>
<td>71.7 a</td>
<td>56.3 a</td>
<td>22.9 c</td>
<td>71.4 a</td>
<td>7.2 ab</td>
</tr>
<tr>
<td>8. Santa Cruz Co., CA</td>
<td>43.5 ab</td>
<td>79.3 bc</td>
<td>50.5 ab</td>
<td>−5.1 a</td>
<td>74.4 ab</td>
<td>0.47 ab</td>
</tr>
<tr>
<td>9. Santa Cruz Co., CA</td>
<td>39.4 ab</td>
<td>77.6 b</td>
<td>31.4 a</td>
<td>20.8 bc</td>
<td>69.7 a</td>
<td>−6.1 a</td>
</tr>
</tbody>
</table>

\textsuperscript{a}Mycelial growth was measured in millimeters per day at 25°C (77°F). Negative values indicate that the fungicide stimulated fungal growth relative to the control. Isolates with the same letter in each fungicide column are not different in percent inhibition (P = 0.05, Dunnett’s T3 test).

\textsuperscript{b}nt = not tested.

Canker size was measured in centimeters squared in the sum-
mer of 2003 using the formula for area of an ellipse (Equation 1):

\[ A = \pi a b \]

\[ a = 1.17 \times R \]

\[ b = 1.44 \times R \]

\[ \pi = \text{pi} \]

Foliar samples were taken from three trees in each treatment
group and analyzed for total phenolic content to estimate the
tree’s defense response. Total phenols were measured using a
modified Prussian blue method (Graham 1992).

### Statistical Analysis

Differences between treatment groups in both in vitro and field
tests were determined using one-way analysis of variance in
SPSS version 10.0. Levene’s homogeneity of variance test was
performed and Dunnett’s T3 test for homogeneous subsets was
used on groups with unequal variance (StatSoft 2004). For data
that did not fit the normal distribution, the Kruskal-Wallis test
was used instead of one-way analysis of variance.

### RESULTS

#### In Vitro Testing of Fungicides

In general, the triazole and benzimidazole fungicides were the
most inhibitory to radial growth of all isolates. The results of the
in vitro tests are given in Table 1.

As expected, the plant activators showed little activity in culture
because their effect is to create a defense response in the
plant host. Inorganic fungicides based on copper and potassium
salts performed less well than the organic fungicides. There were
statistically significant differences among isolates in some of the
fungicidal treatments (Table 3). Complete growth inhibition of
all isolates was seen in the Tebuject, Alamo, Fungisol, Cleary
3,336, and Phyton treatments. These chemicals were used in the
field tests (except for Cleary 3,336). No inhibition of any isolate
occurred in BioSerum™, Aliette, and M-pede treatments, and
fungural growth was stimulated in some cases.

#### Field Tests of Systemic Treatments

All of the wound-inoculated trees developed cankers. Cankers
on all of the injected treatments were smaller than the controls
(Table 4), but the phosphorous acid (BioSerum™) treatment was
the most effective compared with the untreated control group
and canker area was reduced by more than 50% in 2003 (P =
0.01) and almost 70% in 2004 (P = 0.003). Only 3% of all
surface inoculations developed cankers. The treatment groups in

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Table 4. Effect of injected treatments of fungicides and plant activators on Pacific madrone canker growth.\textsuperscript{a}

<table>
<thead>
<tr>
<th>Treatment</th>
<th>2003</th>
<th>2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>124.85 (19.35) b</td>
<td>192.42 (29.83) c</td>
</tr>
<tr>
<td>Alamo</td>
<td>88.43 (13.71) ab</td>
<td>113.97 (17.67) abc</td>
</tr>
<tr>
<td>Arbotect\textsuperscript{b}</td>
<td>83.13 (12.89) ab</td>
<td>93.61 (14.51) ab</td>
</tr>
<tr>
<td>BioSerum\textsuperscript{™}</td>
<td>48.81 (7.57) a</td>
<td>62.72 (9.72) a</td>
</tr>
<tr>
<td>Cambistat</td>
<td>102.83 (15.94) b</td>
<td>165.69 (25.68) bc</td>
</tr>
<tr>
<td>Fungisil</td>
<td>92.54 (14.34) ab</td>
<td>177.77 (27.55) bc</td>
</tr>
<tr>
<td>Phyton</td>
<td>100.03 (15.50) b</td>
<td>117.21 (18.17) abc</td>
</tr>
<tr>
<td>Tebuct</td>
<td>90.32 (14.00) ab</td>
<td>115.76 (17.94) abc</td>
</tr>
</tbody>
</table>

\textsuperscript{a}Mean area of inoculated canker in centimeters squared (inches squared) is given for each treatment during a 2-year period measured in 2003 and 2004. Treatments with the same letter in year column are not significantly different at $P = 0.05$ (Dunnett’s T3 test).

which surface inoculations developed into cankers were Alamo (7%), Fungisol (13%), Phyton (21%), and control (17%).

ALTHOUGH THE DIFFERENCES WERE NOT SIGNIFICANT, CONCENTRATIONS OF PHENOIC DEFENSE CHEMICALS WERE HIGHER IN TREES TREATED WITH PHOSPHORIC ACID, WHEREAS THE CHEMICAL ITSELF WAS INEFFECTIVE AS A FUNGICIDE WHEN TESTED IN CULTURE. THE FUNGICIDE TREATMENT GROUPS WERE NOT SIGNIFICANTLY DIFFERENT WHEN FURTHER SAMPLES WERE COLLECTED ON THE SAME AGE FOLIAGE IN 2004 (1 YEAR AFTER TREATMENT). LEVELS OF PHENOIC CHEMICALS WERE HIGHEST IN THE ARBOTECT\textsuperscript{b} AND BIOSERUM\textsuperscript{™} TREATMENTS, BUT THESE DECREASED AFTER 1 YEAR (Table 5). V ALUES FOR OTHER TREATMENTS INCREASED IN 1 YEAR IN THE SAME FOLIAGE. IN NEW FOLIAGE 1 YEAR AFTER TREATMENT, THE DIFFERENCE BETWEEN GROUPS WAS SIGNIFICANT ($P = 0.011$, Kruskal-Wallis test) with the control and Cambistat treatments having the lowest amount of foliar phenolics and Phyton the highest.

No relationship was found between tree dbh and canker area for individual treatments for both years. A similar result was obtained for the relationship between total foliage and canker area, except in the Arbotect\textsuperscript{b} treatment, in which trees with more foliage had smaller cankers ($r^2 = 0.55$, $P = 0.04$ for 2003, $r^2 = 0.64$, $P = 0.02$ for 2004). There was more of a difference in canker size between treatments 1 year after treatment, and treatment effects seemed more important than the initial health of the tree.

**DISCUSSION**

**In Vitro Testing of Fungicides**

Because chemical fungicides have not been used with *F. arbuti*, the concentration of 200 ppm active ingredient was chosen based on in vitro screening of fungicides for use against *Botrytis cinerea*, in which the 200 ppm dose was found to be suitable for separating effective and ineffective fungicides (W. Littke, pers. comm.). Triazoles and benzimidazoles were most effective as fungicides against *F. arbuti* in culture. Li et al. (1995) using in vitro testing of fungicides against *Botryosphaeria dothidea (Fusicoccum aesculi)* found the most suppression of mycelial growth in plates containing carbendazim and thiophanate-methyl at concentrations of 50 and 100 ppm. These concentrations were lower than the 200 ppm active ingredient concentration used in this study. Fosetyl-Al and phosphorous acid were both inhibitory to *Phytophthora* spp. in culture (Fenn and Coffey 1983) at concentrations ranging from 69 to 552 ppm, but we found they were not inhibitory to *F. arbuti* at 200 ppm. Fenn and Coffey (1983) report that these chemicals had low activity against a range of non-Oomycete pathogens so this result is not surprising. Copper was more effective in inhibiting fungal growth than potassium, but after a period of time in culture, the fungus was observed to accumulate copper from the medium and isolate it. After that, the mycelium was able to grow unchecked. The mela-nized hyphae of *Fusicoccum* protected the mycelium from lysis by potassium salts. These fungicides are commonly used to control powdery mildews (Yildirim et al. 2002) whose hyphae may be more easily disrupted. The response to cinnamaldehyde was extremely variable, perhaps as a result of the volatility of the chemical.

There was variability in tolerance to some fungicides among the nine isolates of *F. arbuti* tested. All were completely inhibited by 200 ppm of the triazole fungicides tebuconazole (Tebuct) and propiconazole (Alamo). In a study of sensitivity of *B. dothidea* to tebuconazole, Ma et al. (2001b) found that sensitivity to tebuconazole correlated significantly with sensitivity to propiconazole. Fungicide concentrations ranged from 0.0625 to 1.0 ppm, much lower than the 200 ppm used in this study. Ma et al. (2001c) found that some isolates of *B. dothidea* developed resistance to iprodione (Rovral) in vitro and remained resistant when treated with up to 500 ppm of the fungicide. There was a range of tolerance to this chemical among isolates of *F. arbuti* at 200 ppm, but the differences were not statistically significant.

Triazole and benzimidazole fungicides were the most effective against *F. arbuti* in vitro and we anticipated that this would translate to reduction of fungal growth in established infections. Inhibition of radial growth by chemicals with fungicidal activity can be an estimator of fungicidal activity in infected host canker tissue, and this was confirmed by some of the field results. However, not all the fungicides that performed well in culture did so in the field and vice versa. How well these chemicals behave in prevention of new infections was not tested in this study and should be done by measuring inhibition of spore germination.

**Field Tests of Systemic Treatments**

Because we did not want to introduce new genotypes of *F. arbuti* to the field site, we chose a local isolate of *F. arbuti* to be used in the field tests. There were no significant differences in sensitivity of isolates from the Puget Sound area to fungicides used in the field tests in vitro, so this isolate could be considered representative of the region. However, a more complete test should include isolates of *F. arbuti* from the entire range of Pacific madrone to fully account for genetic variability.

Table 5. Concentrations of total phenolic chemicals (milligrams per gram dry weight) in madrone foliage for each injected fungicide treatment.\textsuperscript{a}

<table>
<thead>
<tr>
<th>Treatment</th>
<th>2003</th>
<th>2004, old foliage</th>
<th>2004, new foliage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>50.4</td>
<td>58.9</td>
<td>36.9</td>
</tr>
<tr>
<td>Alamo</td>
<td>34.4</td>
<td>61.7</td>
<td>51.3</td>
</tr>
<tr>
<td>Arbotect\textsuperscript{b}</td>
<td>58.4</td>
<td>41.1</td>
<td>54.8</td>
</tr>
<tr>
<td>BioSerum\textsuperscript{™}</td>
<td>59.4</td>
<td>54.3</td>
<td>43.8</td>
</tr>
<tr>
<td>Cambistat</td>
<td>52.9</td>
<td>40.3</td>
<td>39.2</td>
</tr>
<tr>
<td>Fungisil</td>
<td>51.6</td>
<td>52.1</td>
<td>51.1</td>
</tr>
<tr>
<td>Phyton</td>
<td>58.3</td>
<td>58.6</td>
<td>61.4</td>
</tr>
<tr>
<td>Tebuct</td>
<td>48.8</td>
<td>58.6</td>
<td>42.2</td>
</tr>
</tbody>
</table>

\textsuperscript{a}Samples were taken 9 (2003) and 18 (2004) months after treatment with injected fungicides. Old foliage is current year’s leaves; new foliage is newly emerging foliage.
Fusicoccum arbuti appears to be a wound-invading pathogen on woody tissue because 100% of wound inoculations on all trees developed cankers, whereas only 3% of surface inoculations did. No cankers developed from bark surface inoculations in the Arbotect™, BioSerum™, Cambistat, and Tebujet treatments. Perhaps defenses in the bark were stimulated, preventing fungal colonization.

The benzimidazole fungicides, with the exception of Arbotect™, performed less well in the field than in vitro. BioSerum™ (phosphorous acid) was the most effective fungicide in field tests. This is probably attributable to plant defenses being activated and not from fungicidal activity of the chemical. BioSerum™ and a similar product, Alette (Fosetyl-AI), were not inhibitory in culture. The previous in vitro fungicide results suggest the effectiveness of phosphorous acid is the result of stimulating plant defenses rather than direct fungicidal activity.

Treatment with phosphorous acid holds the most promise for madrones in disease prevention and in treating preexisting cankers. Because wounding and disease cause a defense response in trees (Pericival 2001; Krokene et al. 2003), induced defenses already present resulting from active cankers on the tree before treatment with BioSerum™ were increased after treatment. Phosphorous acid, the active ingredient in BioSerum™, has been demonstrated to have a stimulatory effect on host defense responses to infection by Phytophthora spp. (Fenn and Coffey 1983).

Arbotect™ performed almost as well as BioSerum™ and a similar (induced) level of phenolic defense chemicals was seen in the foliage, but decreased in the second year after treatment. Cankers on these two treatments appeared to be more callused than on other treatments. Arbotect™ may behave as a plant activator in addition to having fungicidal properties. Perhaps production of phenolic defense chemicals is less important than growth of callus tissue as a mode of plant defense initiated by these two chemical treatments, although increased foliar phenolics may prevent colonization by fungal pathogens.

All of these fungicides, except for benomyl, are sterol degradable inhibitors and prevent formation of ergosterol in fungi. However, effectiveness of these fungicides may be the result of their behavior in the host rather than fungicidal activity. Sterol-inhibiting fungicides are known to change the balance of plant hormones and reduce transpiration rates in some crops (Lonsdale and Kotze 1993). This confers drought tolerance on the plant and possible resistance to canker fungi such as Botryosphaeria spp., that are pathogenic when the host is under water stress. New infections are prevented during times when stomates are closed.

**Implications for Arboriculture**

Treating Pacific madrone trees with phosphorous acid (BioSerum™) or Arbotect™ will stimulate their defenses and reduce the severity of cankers caused by F. arbuti. These treatments also will prevent some new infections through increased defense chemicals in the foliage. The treatment effect lasts at least 1 year. These treatments may be effective on diseases caused by Botryosphaeria spp. in other hosts in addition to Pacific madrone.

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**LITERATURE CITED**


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Résumé. L’arbousier de Menzies (Arbutus menziesii) a souffert de dépérissement dans la région du détroit du Puget en raison principale-ment d’un chancro causé par le champignon pathogène Fusicoccum arbuti. Les méthodes culturelles telles que la prévention des stress et la chirurgie sont des traitements recommandés pour les arbres atteints par le chancro. Des traitements par injection peuvent aussi être utilisés pour protéger l’arbousier de Menzies dans les zones urbaines. Une expérience mettant à l’essai l’injection de fongicides chimiques et de d’activateurs végétaux a été menée sur des arbousiers de Menzies inoculés avec F. arbuti. Dix-huit fongicides ont été testés en culture et sept parmi ces derniers lors de tests sur le terrain. Il y avait une faible corrélation entre l’activité fungique en milieu culturel et la réduction des chancres dans les tests sur le terrain. Deux traitements qui ont été efficaces pour mini-miser la croissance des chancres sur des arbousiers inoculés étaient l’Arbotect® (un fongicide à base de triazole) et le BioSerum™ (acide phosphorique). Les chancres inoculés sur des blessures étaient 50% plus petits que ceux du groupe témoin et aucune infection n’est survenue sur les sujets inoculés en surface. La formation d’un cal plus important a été observée autour des chancres sur des arbres avec ces traitements et le mode d’action de ces substances chimiques était probablement plus une stimulation des défenses de la plante qu’une action directe du fongicide. L’acide phosphorique est recommandé en sus aux méthodes culturales afin d’améliorer la vigueur de l’arbre, et ce pour les arbousiers de Men- zies de grande valeur dans les aménagements en milieu urbain.


Resumen. El madroño del pacífico (Arbutus menziesii) ha estado sufriendo declinación en el área de Puget Sound, primariamente debido a la enfermedad de cancro causada por el hongo Fusicoccum arbuti. Los métodos culturales tales como prevención del estrés y manejo de cavi-dades son tratamientos recomendados para enfermedades de cancro en los árboles. Los tratamientos con inyecciones también pueden ser usados para proteger madroños valiosos en áreas urbanas. Se realizó un experi-mento probando fungicidas químicos inyectables y activadores vegetales en árboles de madroño inoculados con F. arbuti. Fueron probados 18 fungicidas en cultivo, siete de los cuales fueron usados en pruebas de campo. Hubo poca correlación entre la actividad fungica y la reduc-ción del cancro en las pruebas de campo. Dos experimentos que fueron efectivos en minimizar el crecimiento del cancro en madroños incula-dos fueron Arbotect® (un fungicida con triazol) y BioSerum™ (ácido fosfórico). Los cancos en las heridas inoculadas fueron 50% más pequeños que el grupo de control y no ocurrieron infecciones en los tratamientos sobre superficies inoculadas. Se observaron callos incre-mentados en cancos de árboles con estos tratamientos y el modo de acción para estos químicos es probablemente más la estimulación de las defensas de la planta que la acción fungicida. El ácido fosfórico es recomendado además de los métodos culturales que mejoran el vigor del árbol para madroños de alto valor en paisajes urbanos.