

Effects of Phosphonate Treatments on the Growth of *Phytophthora ramorum* in Tanoak Stems¹

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Introduction

In Oregon, tanoak (*Lithocarpus densiflorus*) is the tree species most susceptible to *Phytophthora ramorum*, and Sudden Oak Death (SOD) occurs only in forests where tanoak is present. Oregon is attempting to eradicate the pathogen by complete destruction of host plants in and near infested sites. Although the eradication effort has been successful to a degree, it is clear that we need other tools to limit spread of the pathogen in forests. The purpose of this study is to begin evaluating phosphonate (Agrifos-400®) treatments as tools for managing SOD in Oregon Forests. Phosphonate (Agrifos-400®) treatments have been shown to reduce *P. ramorum* lesion development in coast live oak and tanoak in California, but the results for tanoak suggest that bark application on tanoak may not be effective (Garbelotto and others 2003). There is little or no information as to whether or not application of phosphonate to the lower bole by any method can reduce infection on the upper stem or foliage, or reduce sporulation on these same parts. The objectives of our study were to: 1) compare the effectiveness of lower bole bark application and trunk injection in terms of lesion development in the lower bole, upper bole, and leaves of tanoak; 2) evaluate the relative effectiveness of a single application of Agrifos® to two applications separated by 3 months; 3) evaluate the relative effectiveness of maximum label rate compared to two times the maximum label rate, and; 4) describe the duration of treatment effect.

Key words: sudden oak death, phosphonate, tanoak, Agrifos®, tree injection, *Phytophthora ramorum*

Methods

Two study sites were located in young-growth tanoak stands on industrial forestland near Brookings, Curry County, Oregon. We tested two methods of application (injection and bark spray), two application rates (maximum label rate (1X) and double the maximum label rate

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(2X)), and two treatment schedules (a single treatment on February 10, 2004 and treatment on February 10 and May 5, 2004. Twelve trees at each site were untreated controls. We injected trees with a Sidewinder[®] tree injector, one injection per 15 cm of trunk circumference at or below 1.5 m. above ground. Holes were drilled approximately 2 cm into the sapwood. The injection fluid was 1 part Agrifos-400[®] and 2 parts water. For the 1X treatment each injection delivered 10 ml of solution. The 2X treatment delivered 20 ml of solution per injection. The 5 mm injection holes were sealed with threaded plastic plugs. We applied Agrifos[®] to the lower 2.5 meters of the trunk with a back-pack sprayer. The 1X spray solution contained 21 parts Agrifos-400[®], 21 parts water, and 1 part pentra-bark[®] surfactant. The 2X treatment was 42 parts Agrifos-400[®], 21 parts water, and 1 part pentra-bark surfactant. Bark was sprayed to runoff. We harvested trees from the February 10-only treatments on April 9 (8 weeks) and on June 23 2004 (18 weeks). We harvested trees from the February 10-May 5 treatments on June 23 and July 26 2004, 7 and 12 weeks after treatment, respectively. At each sampling time we harvested three trees from each treatment at each site plus six control trees (three bark spray controls and three injection controls). We felled each sample tree and cut a 1 meter long (10 to 20 cm diameter) section of bole immediately above the stump and another (3-8 cm diameter) from 10 meters above stump height. We randomly collected 18 leaves from the upper crown of each sample tree. Log ends were sealed with a wax-emulsion sealer to prevent water loss and delivered to Oregon State University in Corvallis, OR. We inoculated each bole section with one of each of the following agar plugs: *P. ramorum* North American genotype-A2 mating type; *P. ramorum* European genotype-A1 mating type, and; sterile V-8 juice agar. We inserted the 5mm diameter plugs into holes created in the bark with a cork borer, and covered the inoculation point with sterile cotton and tape. Logs were incubated inside clear polyethylene sleeves for 4 weeks at constant temperature (21 degrees C). At the end of the incubation period we shaved the bark, measured the longitudinal and radial extent of lesions associated with each inoculation point, and attempted re-isolation of the pathogen from the lesions. We rinsed leaves with sterile water, placed them in a moist chamber, and placed agar plugs of two *P. ramorum* isolates and sterile agar (described above) on the leaf surface. We incubated leaves for 10 to 14 days in the dark at 21 degrees C and then measured the area of necrosis associated with each inoculation point.

Results

For trees treated in February only, after 8 weeks Agrifos[®] applied either by injection or bark spray clearly reduced lesion size in the lower bole, but not in the upper bole. Treatment rate (1X or 2X) did not affect lesion size. The European isolate consistently caused larger lesions than the North American isolate, but the latter was losing vitality in culture and behaving erratically in other studies, and was excluded from subsequent analyses. After 18 weeks, lesion size did not differ statistically (ANOVA, $p > .05$) between treated and untreated stems from either the upper or lower bole. Injection treatments appeared to have a more lasting effect than the bark application.

For trees treated in February and May, after 7 and 12 weeks (following the May treatment) the bark treatments reduced *lower* bole lesion size compared to controls, but injection treatments did not. Injection treatments reduced lesion size in the *upper* bole compared to controls but bark treatments did not. It is possible that injected material moved upward in the xylem stream and accumulated in expanding foliage, whereas bark-applied material may have been absorbed directly into the inner bark. Bark application may be more effective than injection for protecting the bole during spring vegetative growth. Injection may be more effective than bark spray for reducing lesion size in the upper stem. Much statistical variation was due to little or no lesion development at some inoculation points regardless of treatment.

The leaf test failed because unknown micro-organisms confounded lesion measurements. We were unable to determine whether or not Agrifos[®] treatments affected susceptibility of leaves or petioles to infection by *P. ramorum*.

References

Garbelotto, M.,D.; Schmidt, J.; Tjosvold, S.; and T.Y. Harnik. 2003. **Chemical treatment strategies for control of sudden oak death in oaks and tanoaks.** Phytopathology 93: S28.