

Evaluation of Fungicides for the Control of *Phytophthora ramorum* Infecting *Rhododendron*, *Camellia*, *Viburnum*, and *Pieris*¹

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Abstract

Phytophthora ramorum has been detected infecting ornamental hosts in European nurseries and gardens beginning in 1993, and detected in North American nurseries beginning in 2000. Nursery operators need a comprehensive program to insure that nursery stock remain disease free. Fungicides could be part of an integrated pest management approach to meet that goal. It is also important to evaluate whether fungicides are masking symptoms and the detection of the pathogen.

For two years we evaluated fungicides for the prevention and eradication of *P. ramorum* on four important ornamental genera of nursery hosts: two cultivars of *Rhododendron* (R. 'Cunningham's White' and R. 'Irish Lace') in 2003, and *Camellia japonica* 'Elena Nobile', *Pieris japonica* 'Whitewater', and *Viburnum tinus* 'Compacta' in 2004. First, we screened prospective fungicides by evaluating the preventative control of a wide range of commercially-available and experimental Oomycete fungicides. Second, we selected the fungicides that provided the best efficacy in the fungicide screen and repeated these applications to determine their residual action to prevent infection. Efficacy was also judged by how well the pathogen was recovered from lesions resulting from infections. Finally, the eradication potential of these fungicides were judged by the success of recovery of the pathogen from lesions that were treated with these fungicides.

Key words: *Phytophthora ramorum*, fungicide, Azalea, fosetyl-Al, phosphorous acid, copper sulfate pentahydrate, cuprous oxide, azoxystrobin zoxamide, mancozeb

Rhododendron (2003)

Screen potentially effective fungicide

In both R. 'Cunningham's White' and R. 'Irish Lace', the treatments that provided the smallest lesion development were mefenoxam (foliar), dimethomorph, fenamidone, and pyraclostrobin. Cuprous oxide was ineffective on both cultivars and was removed from subsequent experiments. Fosetyl-Al applied as a soil drench was not effective, but the foliar

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treatments were somewhat better than the water check. Fosetyl-Al as a foliar treatment was still included in subsequent experiments to see if additional time for metabolism and movement might result in better efficacy. Plants treated with copper sulphate pentahydrate developed significant phytotoxicity on both cultivars.

Determine residual fungicidal action

All tested fungicide treatments were effective in reducing lesion development if applied 1 day, 1 week or 2 weeks before inoculation, but not if applied 4 weeks before inoculation. There were no differences of lesion development that could be attributed to a specific fungicide. The pathogen was re-isolated from a high percentage of leaves from most treatments. However, recovery was consistently lower in those leaves that were treated with dimethomorph over all treatment-time regimes.

Determine eradication action

Post-infection fungicide treatments did not impede lesion development on infected leaves remaining on the plant or leaves that abscised. When sampled up to 6 weeks after fungicide treatment, intact leaves had lesions that covered 13.0 to 32.0 percent of the leaf with a mean coverage of 23.0 percent. Fallen leaves had lesions that covered 44.0 to 88.0 percent of the leaf with a mean of 61.0 percent. There were no significant differences (ANOVA) in lesion development between treated and water-check treated lesions for intact and abscised leaves. In addition, *P. ramorum* was usually readily re-isolated. There was a general decline of isolation success with time, and isolation was less successful on fallen leaves.

Camellia, Viburnum, and Pieris (2004)

Screen potentially effective fungicides

The treatments had similar relative effects, regardless of species, even though leaf lesions of each species had different growth rates. Dimethomorph, pyraclostrobin, fenamidone, mefenoxam provided preventative control better than the other fungicides, as they did in the fungicide screen for rhododendron. Zoxamide and cyazofamid were tested on these species and provided preventative control. There was less control with mancozeb, zoxamide + mancozeb, azoxystrobin, mono and di-potassium phosphorous acid and fosetyl-Al than with the other fungicides.

Determine residual fungicidal action

For camellia, several fungicides provided preventative control for at least 2 weeks. Generally efficacy was not as strong at 4 weeks as indicated by weaker statistical significance ($p < .06$), although cyazofamid and dimethomorph were clearly efficacious at 4 weeks. For Japanese pieris and viburnum, dimethomorph, fenamidone, and cyazofamid provided preventative

control for up to 4 weeks. To a lesser extent, mefenoxam, pyraclostrobin, and zoxamide provided preventative control. There were generally lower isolation success rates with dimethomorph and cyazofamid.

Determine eradication action

Post-infection fungicide treatments did not impede lesion development on infected leaves when lesion size was evaluated 2 weeks after fungicide treatment. There were no significant differences (ANOVA) in lesion development. Lesion diameter varied with species, with mean diameters at 2 weeks for Japanese pieris, camellia and viburnum, 33.6, 19.8 and 11.1 mm respectively. In addition, *P. ramorum* was commonly re-isolated, with no significant differences between fungicide treatments and the water-check. Success rate for isolation varied from 86 to 100 percent. Even though isolations were highly successful there was a difference in the general vigor of growth from isolation. Fungicide treated isolations were weaker, especially when treated with cyazofamid and dimethomorph.

Summary

Cyazofamid, dimethomorph, mefenoxam, pyraclostrobin and fenamidone applied as foliar sprays consistently provided preventative control as expressed by reduced lesion size compared to water controls. These fungicides provided preventative activity for at least 4 weeks, except in rhododendron in which the tested fungicides were active up to 2 weeks following their application. When lesions occurred, the pathogen was successfully recovered from the lesions by isolation on selective media. Only cyazofamid and dimethomorph significantly reduced the success of isolation recovery. Post-infection treatments of leaf lesions with foliar- and soil-applied fungicides were ineffective in reducing the size of lesions and the success of pathogen recovery from those lesions. The pathogen was recovered from lesions consistently for at least 6 weeks after fungicide application in rhododendron regardless of treatment.

Fungicides will not be effective in eradicating existing infections and lesion development is not slowed significantly by fungicide application. Infected plants will need to be destroyed in quarantine situations. Laboratory isolation success declines with time after fungicide application and infection so agricultural inspectors should locate leaves that have recently formed lesions for isolation. Lesion development can occur even with preventative fungicide application for various reasons: imperfect application uniformity, incomplete movement of fungicide, inherent fungicide efficacy, and weakened or wounded plants. If lesions occur, cyazofamid and dimethomorph could have a significant negative impact on isolation recovery.