

# Relative virulence of *Phytophthora* species, including the sudden oak pathogen, *P. ramorum*, on leaves of several ornamentals

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## Abstract

Several *Phytophthora* species cause leaf and shoot dieback diseases of ornamentals similar to that caused by the Sudden Oak Death pathogen, *P. ramorum*. Detached leaves of several landscape plants were inoculated with *P. ramorum*, *P. cactorum*, *P. syringae*, *P. citricola*, *P. heveae*, *P. parasitica*, *P. citrophthora*, and *P. cinnamomi*. Rhododendron, Pieris, and Laurel were the most susceptible to the most pathogens, based on lesion-severity ratings, with variation depending on the host-pathogen combination. Few hosts were not susceptible to some *Phytophthora* species, and most pathogens infected some hosts. Necrotic lesions were initially similar, but generally with most pathogens subsequent spread was limited. In contrast, *P. ramorum* and *P. citrophthora* lesions spread throughout the entire leaf, suggesting greater virulence and thus underscoring the risk to nursery and landscape plants should the quarantined *P. ramorum* become more widespread.

## Introduction and Background

The discovery and naming of *Phytophthora ramorum* as the cause of leaf infections on rhododendron and viburnum in Europe (3), and its identification as the cause of the Sudden Oak Death disease syndrome responsible for killing trees and shrubs in the forests of California and Oregon (2) underscores the threat and risk that the pathogen poses to the nursery and small fruit industries that grow plants in the plant genera involved, especially members of the Ericaceae such as Rhododendron or Vaccinium, and the Fagaceae including oaks (*Quercus* spp.) and tanoak (*Lithocarpus densiflorus*). The symptoms caused by *P. ramorum* on rhododendrons are remarkably similar to those caused by other *Phytophthora* pathogens known to exist in the nursery industry, including *P. cactorum*, *P. citricola*, *P. citrophthora*, *P. syringae*, *P. heveae*, *P. parasitica*, and *P. cinnamomi* (1).

The purpose of our studies was to inoculate a wide range of nursery crop plants with all the above *Phytophthora* species in order to answer the following questions:

- (1) How would nurserymen or inspectors know when *P. ramorum* had infected nursery plants? Are there any distinguishing symptoms of *P. ramorum* infections compared to other *Phytophthora* species?
- (2) How extensive is the nursery crop host list for *P. ramorum*?
- (3) Is *P. ramorum* more virulent than the other *Phytophthora* species known to infect rhododendrons or other nursery plants?

## Materials and Methods

Detached leaves of a wide taxonomic range of nursery crops were inoculated in moist chambers with mycelial plugs taken from the colony margins of all the *Phytophthora* species, incubated at 20°C for 14 days with periodic misting, and rated visually for severity of lesion symptoms caused. Visual ratings were: 1 = no lesion, 2 = lesion twice the diameter of the inoculum plug, 3 = lesion diameter up to 2 cm, and 4 = lesion greater than 2 cm and spreading to adjacent inoculation sites and across the mid-vein of the leaf. Plant species with large enough leaves were inoculated at three needle-wound sites on one side of the leaf, and one non-inoculated on the opposite side (an agar plug only). Small leaf plants were inoculated with a single plug per leaf, detached from the shoot or retained on small branchlets.

## Results

The results indicated that on any host plant, symptoms caused by all the *P.* species were essentially the same, although some *P.* species were clearly more virulent than others. Lesions were dark and necrotic and spread to varying extents from the inoculum plug. In severe reactions on inoculated branchlets (*Cotoneaster*, *Arctostaphylos*), leaves abscised and infections spread to the stem tissue. With Portugese and English Laurel, lesions turned into large shot-holes that dropped out of the leaf. In general, symptoms caused by any of the species of *Phytophthora* were the same, differing only in severity. Species of *Rhododendron*, *Pieris*, *Vaccinium*, *Syringa*, and *Prunus* (Laurel) were the most susceptible to the most *P.* species. Some plant species were susceptible only to *P. ramorum* but not other *P.* species (*Viburnum davidii* and *V. plicatum* var. *tomentosum*), while others were susceptible to other *P.* species but not *P. ramorum* [ivy, *Hedera helix*, and salal (*Gaultheria shallon*)]. A few plants, such as *Camellia japonica*, *Ilex aquifolium*, and *Pachysandra terminalis*, were essentially not susceptible to any species of *Phytophthora*, and others, such as *Leucothoe axillaris*, *Nandina domestica*, Oregon grape (*Mahonia aquifolium*), and 'Macrantha' azalea, were only slightly susceptible to any *Phytophthora* species. The more severe symptoms caused by the most virulent *P.* species were larger than 2 cm in diameter, and often spread across the midvein. *P. ramorum*, *P. citrophthora*, *P. citricola*, were the most aggressive/virulent pathogens, often spreading throughout the entire leaf.

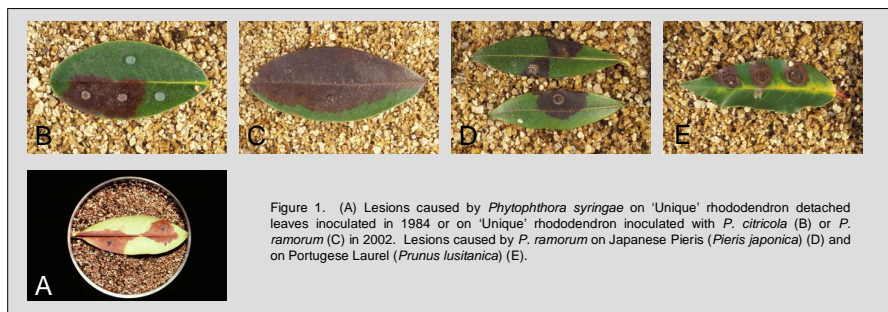


Figure 1. (A) Lesions caused by *Phytophthora syringae* on 'Unique' rhododendron detached leaves inoculated in 1984 or on 'Unique' rhododendron inoculated with *P. citricola* (B) or *P. ramorum* (C) in 2002. Lesions caused by *P. ramorum* on Japanese Pieris (*Pieris japonica*) (D) and on Portugese Laurel (*Prunus lusitanica*) (E).

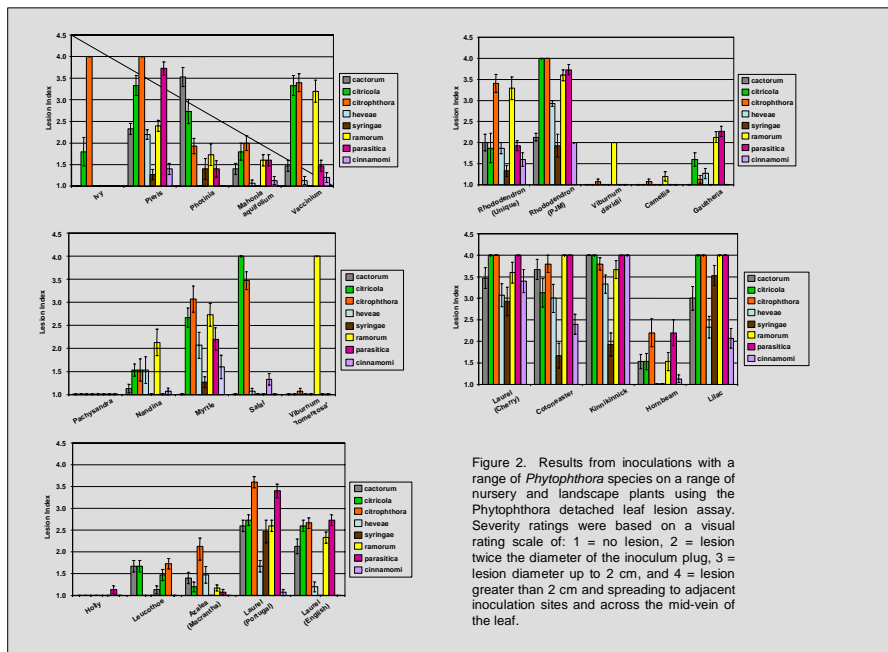


Figure 2. Results from inoculations with a range of *Phytophthora* species on a range of nursery and landscape plants using the *Phytophthora* detached leaf lesion assay. Severity ratings were based on a visual rating scale of: 1 = no lesion, 2 = lesion twice the diameter of the inoculum plug, 3 = lesion diameter up to 2 cm, and 4 = lesion greater than 2 cm and spreading to adjacent inoculation sites and across the mid-vein of the leaf.

## Discussion

These results suggest that *P. ramorum*, *P. citrophthora*, and *P. citricola* pose the greatest risk to nursery and landscape plants should they become more widespread. The potential for *P. ramorum* to spread within the nursery, however, appears to be greater than other *P.* species by virtue of its unusual capacity to produce abundant deciduous sporangia that would facilitate spread within the nursery, and its fairly broad temperature range. In addition, the capacity of *P. ramorum* to produce abundant chlamydospores in or on infected leaf tissue suggests great capacity for long-term survival. These results also indicate that a wide range of nursery and landscape plants should be surveyed for early detection of *P. ramorum* and other aggressive species in the nurseries and landscapes.

## References

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