Susceptibility of Azalea (*Rhododendron*) to *Phytophthora ramorum*

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Introduction

Phytophthora ramorum, the causal agent of the disease commonly known as Sudden Oak Death, is a prevalent pathogen in California with its effects evident in 12 counties and found on 14 different oak, tanoak and non-oak hosts. The *Rhododendron* genus includes the rhododendron and azalea subgenera that are very important horticultural commodities and potentially could be important long-distance carriers of *Phytophthora ramorum* through commercial trade. Although plants of the rhododendron subgenus have been found naturally infected in commercial nurseries and landscapes, plants in the azalea subgenus, so far, have not been found naturally infected. The question arises as to whether azaleas are susceptible to *P. ramorum*, and, if so, to what extent.

Materials and Methods

Twenty-two commercially available *Rhododendron* cultivars or species were tested for susceptibility to *P. ramorum* in a series of experiments. Plants were selected to include genetically diverse, deciduous and evergreen azaleas. See table 1. *Rhododendron* 'Cunningham's White' was used in all experiments as a standard susceptible rhododendron cultivar.

Susceptibility was gauged using six inoculation methods:

Host and environmental conditions:

Inoculations were made either on (1) leaves on potted plants in a 18° C (mean) greenhouse , or (2) detached leaves and incubated in a 20° C (constant) dark chamber at high humidity.

P. ramorum (rhododendron isolate) inoculum:

1. Mycelial agar plugs with pin wounding (paired with agar plugs, no inoculum, with pin wounding).

2. Mycelial agar plugs without pin wounding. On intact plants, the plug was held in place with medical tape.

3. Zoospore suspension
Detached or intact leaves of the plant were inoculated for 24 hours with approximately 5000 zoospores in 20 ml deionized water in a 50 ml beaker. Detached leaves were laid on sterile vermiculite in trays and inoculated in the incubator. Inoculated leaves of intact plants were sealed with a plastic bag.

Susceptibility was gauged by various techniques depending on the inoculation method. With the agar plugs and pin-wounding method, susceptibility was gauged by measuring the difference in lesion size resulting from inoculated and non-inoculated wounding.

Table 1 Cultivars and Species Tested and Characteristics

Cultivar or species	E or D*	Subseries**	Origin***
'Albert and Elizabeth'	E	Chinese	Vervaenana Series
'Ben Morrison	E	Kyushu group	Kaempferi Hybrids
'Blue Danube'	E	Kyushu group	Kaempferi Hybrids
'Cherry Ripe'	E	Kyushu Group	Kurume Hybrids
'Cunningham's White'	E		R. caucasium x R.ponicum
'Formosa'	E	Chinese	Phoenicium hybrid
'Gardener's	E	Kyushu group	R. kiusianum
'Gwenda'	E	Indica group	Satsuki hybrids
'Hino-Crimson'	E	Kyushu group	'Amoenum' x 'Hinode Giri'
'Irish Lace'	E		Unknown, Yoder hybrid
Madonna	E	Chinese Group	Belgian indica hybrid
Northern Hi-Lights	D	Kyushu group	Exbury x seedling
'Okusatuki'	E	Indica group	R. indica or R. tamurae
'Prize'	E	**	Unknown, Yoder hybrid
'Purity'	E	Chinese group	Rutherfordiana hybrid
R. austrinum	D	Luteum Alliance 1	species
R. occidentale	D	Luteum Alliance 3	species
R. schlippenbachii	D	Schlippen-bachi	species
R. viscosum	D	Luteum Alliance 4	species
R. yedoenses var. poukhanense	E	Korean group	species
'Remembrance'	E		Unknown, Yoder hybrid
'Twenty Grand'	E	Kyushu and Chinese	Pericat hybrid

* Evergreen (E) or Deciduous (D)
** Subseries relates to taxonomic classification
*** Origin relates to parentage

Table 2 Susceptibility: zoospore inoculation, detached leaves, and chamber incubated

Rhododendron	*% w/ symptoms*	*% isolation success*
Albert and Elizabeth	87.5	42.9
Ben Morrison	75	66.7
Blue Danube	75	83.3
Cherry Ripe	75	83.3
Cunningham's White	100	87.5
Formosa	62.5	100.0
Gardener's	75	16.7
Gwenda	25	100.0
Hino-Crimson	87.5	57.1
Irish Lace	100	87.5
Madonna	62.5	100.0
Northern HiLights	87.5	57.1
Okusatsuki	87.5	71.4
Prize	62.5	100.0
Purity	25	100.0
Remembrance	37.5	0.0
Twenty Grand	75	83.3

Results

Inoculum plugs: With detached leaves, pin wounding proved necessary to reliably infect intact plants. See figures 1 and 2. With intact plants in the greenhouse, only 3.6% of inoculations were successful without pin wounding (data not shown). However, with pin wounding, differences in plant susceptibility were demonstrated. See figure 3.

Zoospore inoculum: Infection was most successful when leaves were removed, inoculated, and incubated in the humid chamber rather than the leaves inoculated and incubated, intact, on the plant in the greenhouse.

Zoospore inoculation of detached leaves resulted in small lesions forming on all cultivars. *P. ramorum* was successfully isolated from these lesions in all but one cultivar. In those leaves where lesions were formed, the pathogen was isolated in 17 to 100 percent of those cases. See table 2.

Zoospore inoculation in the greenhouse on intact plants had poor infection rate. Only 17 % of the inoculated leaves became infected in *R.* 'Cunningham's White', and no other infection obviously occurred on other plants (data not shown). Variable temperature in the greenhouse during infection and incubation could have resulted in the poor infection rate relative to the infection rate in the incubator.

Fig. 3 Susceptibility: pin wounding, inoculum plug, intact plant in greenhouse (means and 95% confidence)

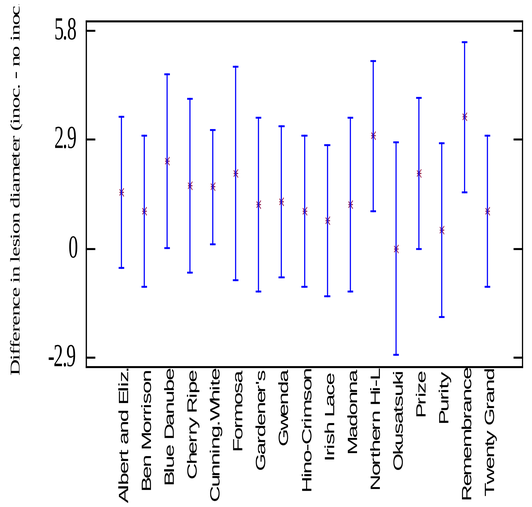


Fig. 1 Susceptibility: no pin wounding, inoculum plug, detached leaves and incubated (means and 95% confidence)

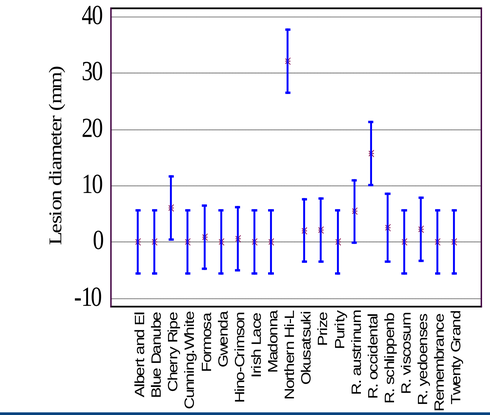
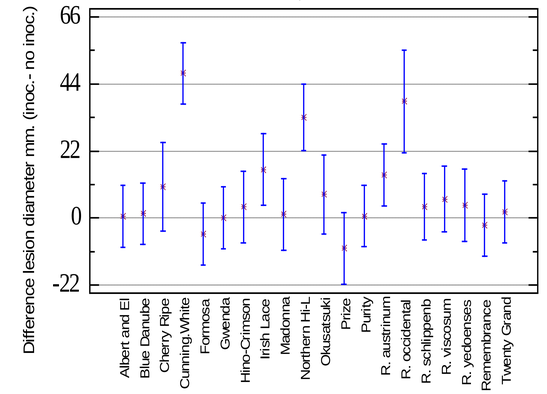


Fig. 2 Susceptibility: pin wounding, inoculum plug, detached leaves and incubated (means and 95% confidence)



Conclusion

The deciduous azaleas 'Northern Hi-lights' and *R. occidentale*, and the standard susceptible rhododendron, 'Cunningham's White', proved to be highly susceptible. Most other azaleas are susceptible to *P. ramorum* using these inoculation techniques, but generally symptoms are weakly expressed.

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