

# Pathogenicity of *Phytophthora* Species Isolated From Rhizosphere Soil in the Eastern United States<sup>1</sup>

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## Abstract

Pathogenicity of seven *Phytophthora* species was assessed by inoculation of stem and foliar tissues of oak species (*Quercus* spp.) native to the eastern United States. *Phytophthora cambivora*, *P. cinnamomi*, *P. citricola*, *P. europaea*, *P. quercina* 'like', *P. sp1* and *P. sp2* were inoculated into stems of 1-year-old greenhouse seedlings and 2-year-old oaks grown under field conditions. Stem inoculations were conducted for 2-month periods in June and September (summer inoculation) and in October-December (fall inoculation). Stem inoculation was conducted by inserting an agar plug containing mycelium on a U-shaped wound, made aseptically about 3 cm above the root collar. Oak species used for 1-year-old stem inoculations included *Q. bicolor*, *Q. macrocarpa*, *Q. montana*, *Q. palustris*, and *Q. rubra*; 2-year-old seedlings included *Q. alba*, *Q. montana*, *Q. palustris*, *Q. rubra* and *Q. velutina*. Leaf inoculations also were conducted using oak and understory plant species to evaluate the ability of the *Phytophthora* species to infect foliar tissue. These tests included foliage of the six oak species that were tested as part of the stem inoculation experiments and foliage of *Q. alba*, *Q. imbricaria*, *Q. robur*, *Castanea dentata*, *Kalmia latifolia* and *Rhododendron maximum*. Two leaf age categories were used: leaves that were fully developed and up to 3 months in age; and, leaves that were 3 to 6-months old. Wound and non-wounded treatments were applied to each age category.

When 1-year-old seedlings grown under greenhouse conditions were tested, *P. cinnamomi* and *P. citricola* were the most aggressive species producing significantly larger lesions on all seedlings during the two inoculation periods. *Phytophthora quercina*-like and *P. sp1* did not cause lesions on any seedlings. Significant variation in lesion sizes did not exist for the other *Phytophthora* species that produced lesions. Of the oak species tested, *Q. palustris* was the most resistant oak, although *P. cinnamomi* and *P. citricola* were able to produce significantly larger lesions on this host when compared to the controls. The largest lesions were produced on *Q. rubra* and *Q. montana*. Generally, no significant difference in lesion size was detected when the summer and fall inoculation periods were compared using ANOVA. Exceptions occurred when *Q. macrocarpa* were inoculated with *P. cambivora* and *P. citricola* during the fall resulting in significantly larger lesions and on *Q. rubra* inoculated with *P. cinnamomi* and *P. cambivora*, which the latter produced significantly larger summer lesions when compared to those made in the fall.

When lesions were formed on the 2-year-old field-grown seedlings, generally lesions that resulted from summer inoculations were larger than those made in the fall. Summer inoculations with *P. cambivora*, *P. europaea*, and *P. sp2*, resulted in significantly larger

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lesions when compared to the controls, however, the same differences were not significant when fall inoculations were compared to the controls. For *P. cinnamomi*, the lesions produced by this isolate were significantly reduced but still larger than the control inoculations during either time period. However, on *P. citricola* lesions were significantly larger than the controls and remained unchanged when spring and fall inoculations were compared. *Phytophthora quercina*-like and *P. sp1* did not cause lesions on any seedlings during either inoculation period. When oaks were ranked for their susceptibility based on lesion formation, *Q. montana* was the most susceptible and *Q. palustris* the least susceptible species, but ANOVA detected no large variations in susceptibility among the oak species.

For the foliar experiments, generally young foliage was more susceptible than mature foliage when lesion sizes were compared. Wounding also resulted in more consistent infections and larger lesions. The most invasive species was *P. citricola*, but *P. cinnamomi*, *P. cambivora* and *P. europaea* also were able to cause infections. *P. quercina*-like was the only isolate that was unable to produce lesions significantly larger than the controls. The largest lesions were observed on young wounded foliage of *Q. rubra* and *C. dentata*. For mature wounded foliage, lesions developed best on *K. latifolia*, *Q. alba* and *C. dentata*. Young and mature wounded foliage of *Q. imbricaria*, *Q. bicolor* and *Q. palustris* were the most resistant to lesion formation with no *Phytophthora* species causing any significant infections. In experiments using mature unwounded foliage, generally none of the *Phytophthora* species were able to cause infections except on *Q. alba*.

These artificial inoculation experiments, utilizing young oak seedlings, demonstrated the pathogenicity of the *Phytophthora* isolates collected from oak forests in the eastern United States. Under greenhouse conditions the *Phytophthora* species gave variable results with regard to the lesions they produced but generally each species performed consistently when summer and fall inoculation periods were compared. However, when 2-year-old field grown seedlings were used, the lesion sizes were significantly reduced in fall experiments suggesting an effect of lower, late season temperatures. The experimentation implies that the susceptibility of an oak species needs to be evaluated over an extended time period so that the environmental components that influence the aggressiveness of these organisms under field conditions can be determined.

Key words: *Phytophthora* species, oaks, pathogenicity.