

Seedling Resistance to *Phytophthora cinnamomi* in the Genus *Abies*

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Cultivation of Fraser fir (*Abies fraseri* [Pursh] Poir.) as Christmas trees is a significant industry in the Southern Appalachians. In western North Carolina alone, 5.5 to 6.0 million trees are harvested yearly with annual revenues exceeding \$100 million (McKinley 1996). Regionally, significant mortality occurs in many Christmas tree nurseries and plantations due to root rot disease caused primarily by *Phytophthora cinnamomi* Rands (Benson and Grand 2000). While chemical methods are available for controlling this disease in seedling and transplant beds, chemical control in plantations is stop-gap at best (Sidebottom et al. 1995). Severely infested sites must be abandoned, perhaps permanently, for Fraser fir production.

Since genetic resistance is widely used to combat diseases caused by *Phytophthora* spp. in agriculture and horticulture (Erwin and Ribeiro 1996), earlier research efforts focussed on identifying resistant Fraser fir material in greenhouse inoculations trials. These trials have confirmed experiences in highly infested Christmas tree plantations, that Fraser fir is extremely susceptible to *P. cinnamomi*. Overall, mortality of seedlings in one greenhouse inoculation trial was 90% after 122 days but varied significantly among geographic seed sources (Frampton and Benson 2004). In another greenhouse inoculation trial, mortality of 100 Fraser fir open-pollinated families from a single geographic source ranged from 91 to 100% four months following inoculation with 42 families exhibiting 100% mortality (Frampton et al. 2003). Surviving seedlings from both of these studies eventually died and in a follow-up study, all seedlings from 100 open-pollinated families representing each of the six major geographic sources of Fraser fir died within four months of inoculation (Unpublished data, Frampton and Benson 2003).

In the current study, variation of resistance to *P. cinnamomi* was examined in the true firs (*Abies*). Thirty-two species (52 unique taxa) were grown in a greenhouse for two and/or three years from seed. Seedlings were moved to an outdoor lath house, inoculated with rice grains colonized with *P. cinnamomi*, and subsequent mortality assessed biweekly for 16 weeks.

Disease developed rapidly resulting in 87.5% overall mortality after 16 weeks. Final species mortality ranged from 11.3% (*A. firma*) to 100.0% (several species). Hierarchical cluster analysis was used to classify species into resistant (2), intermediate (9), and susceptible (21) groups based on 16 week mortality. All North American *Abies* species were classified as susceptible with the exception of *A. concolor* which was classified as the most susceptible intermediate species. Species classified as resistant and intermediate are native to Eastern Europe and Central Asia plus Japan (*A. firma*). This geographic distribution of resistance may reflect 1) past contact with *P. cinnamomi* during the evolutionary history of the genus or, 2) adaptation to particular environmental factors such as climate or soils that also affect resistance.

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Although many caveats apply when drawing conclusions from this research, results have helped identify likely sources of *Abies* to be used as resistant rootstock or in hybridization/backcrossing breeding programs in order to improve resistance in susceptible species.

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