

GROWING KNOWLEDGE

Series content is coordinated by Dr. Lloyd Nackley, associate professor of nursery production and greenhouse management at Oregon State University in Corvallis, Oregon.



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A microscopic threat

Managing *Phytophthora*: timing, temperature and emerging threats



Figure 1: Rhododendrons with increasing root rot severity (left to right) showing how above ground symptoms lag behind root damage. Despite 30% root loss, the plant on the right showed no obvious above ground symptoms, while the middle plant with 50% root loss appeared stunted but maintained green foliage. Both plants died later in summer when warmer temperatures increased water demand. The plant on the left collapsed more quickly after losing 75% of its roots. PHOTO COURTESY OF USDA-ARS.

BY ALAN PEPPER
AND JERRY WEILAND

Phytophthora root rot is a persistent and economically significant issue in the ornamental nursery industry. Several soilborne *Phytophthora* species attack plant roots at every stage of production — from propagation benches to container systems to in-ground field operations. Unlike aerial *Phytophthora* species that cause visible stem cankers, dieback, and leaf blight, root rot species remain hidden below ground where infection can go unnoticed until plants sud-

denly wilt and collapse.

Phytophthora species belong to a group of microscopic organisms commonly known as “water molds.” As their name suggests, water molds thrive under wet conditions. They produce motile zoospores that swim through water to infect roots. In nursery environments where overwatering, poor drainage, and close plant spacing are common, these pathogens can spread rapidly.

Phytophthora also produce thick-walled survival spores (oospores or chlamydospores) that persist in plant debris and soil for years, withstanding drought

and temperature extremes from below freezing to above 100 F. Once favorable conditions return, these spores resume growth and begin the infection cycle again. Only sustained high temperatures — such as soil pasteurization at 140–180 F for 30 minutes — can kill them. This makes *Phytophthora* extremely difficult to eradicate once established in the nursery.

Adding to the challenge, many *Phytophthora* species have a wide host range and can infect several to hundreds of different horticultural crops. For example, *P. cinnamomi* alone infects over 5,000 plant species and has long been >>

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Growing Knowledge

considered one of the greatest threats to the industry.

The rise of *P. plurivora* in Northwest nurseries

Our research focuses on improving *Phytophthora* root rot management practices, with a particular emphasis on rhododendrons because of their economic importance to the Pacific Northwest nursery industry. *P. cinnamomi* had been considered the primary cause of root rot on this crop. However, our research revealed that *P. plurivora* has become much more common than *P. cinnamomi* in Northwest nurseries. This shift has important biological and management implications.

Unlike *P. cinnamomi*, which primarily infects roots, *P. plurivora* can infect both aboveground (stems and leaves) and below ground tissues (roots). This infection strategy gives *P. plurivora* a competitive advantage, allowing it to spread more rapidly in nurseries than *P. cinnamomi*. In addition, regional populations of *P. plurivora*, but not *P. cinnamomi*, have developed resistance to two commonly used fungicides, mefenoxam and phosphorous acid. As a result, Oregon growers have experienced significant crop losses due to fungicide resistant populations. We are therefore evaluating alternative fungicide chemistries as potential replacements to help growers manage this evolving threat.

Understanding temperature-driven disease patterns

Given that biological differences between *P. cinnamomi* and *P. plurivora* have already affected fungicide control, we were curious whether these two species also differ in their responses to temperature: finding the answer could help growers better time their fungicide applications to minimize disease.

To find out, we ran a series of experiments to examine how different temperatures affected the ability of each species to grow, sporulate, and cause disease.

Our results revealed that although both species grow best at 80 F, *P. plurivora* grows faster than *P. cinnamomi* at cooler temperatures (50–60 F), while

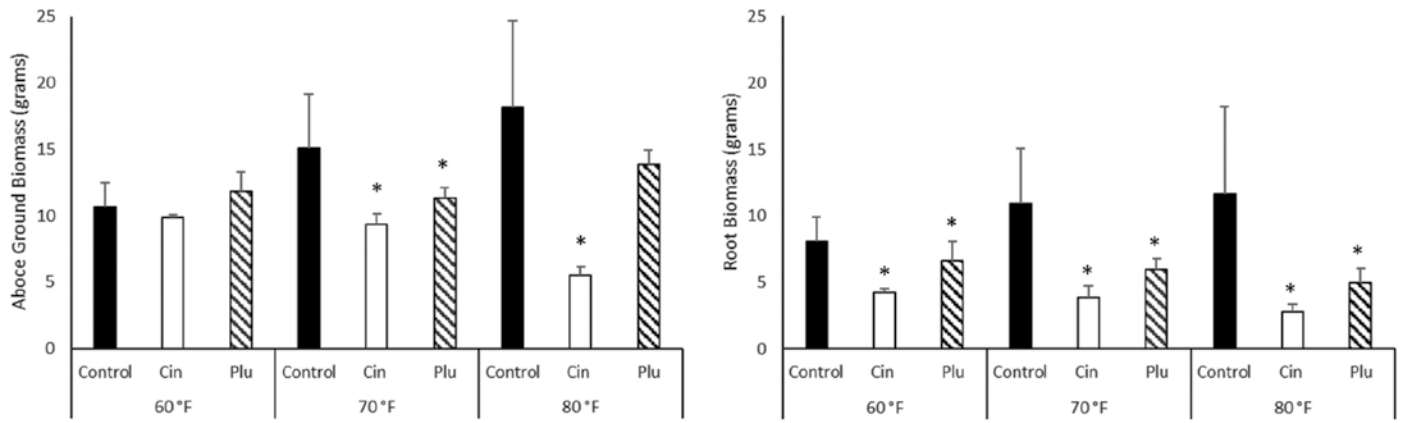


Figure 2. Rhododendron above ground and below ground biomass after infection by *P. cinnamomi* and *P. plurivora* compared to a healthy control. Asterisks (*) indicate a significant difference from the control. Results show that at colder temperature (60 F) there is no difference between the control and infected groups in above ground biomass, however the root biomass is shown to have significant root loss.

P. cinnamomi grows faster than *P. plurivora* at warmer temperatures (near 90 F). Sporulation followed a similar pattern with *P. plurivora* producing more zoospores at cooler temperatures (50–80 F) and *P. cinnamomi* producing more zoospores at warmer temperatures (60–90 F).


These temperature preferences matter because growth determines how fast each pathogen colonizes the roots after infection, while sporulation determines how

many zoospores are produced to infect new plants. Together, growth and sporulation drive infection potential. Based on these patterns, we predicted that *P. plurivora* would cause more disease at lower temperatures, while *P. cinnamomi* would be favored at warmer temperatures.


Our infection experiments confirmed these predictions — with important nuances. Although *P. plurivora* killed more plants at cooler temperatures (60–70

F) and *P. cinnamomi* killed more at 80 F, both pathogens caused similar amounts of root damage across a range of different temperatures. Plant mortality increased with temperature for both species, rising from just a few deaths at 60 F to substantial losses at 80 F. The key finding: both pathogens cause significant disease across a broader temperature range than previously recognized, with considerable overlap in their activity despite *P. cinna-*

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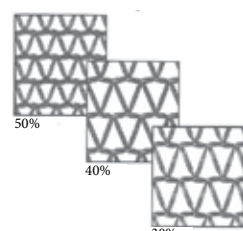


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Figure 3. A disease pocket of *Phytophthora* root rot in a low-lying area where water collects. Plants in the center died shortly after planting, while plants at the outer edge where drainage was better survived longer but ultimately succumbed (scattered brown plants). PHOTO COURTESY OF OREGON STATE UNIVERSITY

momi's preference for warmer conditions and *P. plurivora*'s for cooler ones.

These findings have important practical consequences for disease management. Because both pathogens are active across an extended seasonal window — from spring through fall — effective management may require starting fungicide applications earlier in the spring and extending them later into the fall than has been traditionally practiced.

The production environment also influences disease risk. Greenhouses maintain warmer temperatures that may favor *P. cinnamomi* year-round or shift its activity earlier in the year. Black plastic containers and black plastic weed mat also increase soil temperatures: both create warm zones that favor *P. cinnamomi* even when ambient temperatures are more moderate. In contrast, wood chip mulch and light-colored containers keep root zones cooler, potentially favoring *P. plurivora*. Growers should therefore consider how their own nursery management practices may influence temperature when timing fungicide applications for each production area.

The hidden damage problem

One of the most important observations from our temperature trials was the disconnect between below ground damage

and aboveground symptoms. At 60 F, both pathogens caused approximately 25% root loss, yet visible symptoms of wilting, yellowing, and leaf drop were largely absent. Few plants showed obvious above ground symptoms at this temperature even though damage underground was already substantial. This means growers may not realize they have a root rot problem developing when temperatures are cooler.

During cool, wet weather in spring and fall, plants grow slowly and use very little water. Even with compromised roots, they can still supply enough water to keep leaves and stems looking healthy. Meanwhile, *Phytophthora* may slowly be destroying the root system below ground.

The problem becomes apparent when temperatures rise and plants enter active growth. Water demand increases sharply, but the damaged roots can no longer keep up. As a result, plants that previously looked healthy may suddenly wilt and collapse. By the time growers notice symptoms, most of the damage has already occurred. This is why preventative management is critical. Fungicides must be applied before infection occurs to be effective and minimize disease losses.

A new threat

Phytophthora austrocedri, a relatively newly discovered *Phytophthora*

Practical management guidelines

- **Scout for disease** regularly.
- **Test soil and plants** early if problems are suspected.
- **Cull infected plants** immediately and keep cull piles away from production areas.
- **Do not compost** or reuse contaminated soil.
- **Inspect and quarantine** incoming plant material.
- **Avoid overwatering, improve drainage**, and prevent standing water.
- **Disinfect recycled irrigation** water.
- **Use new pots** or thoroughly sanitize before reuse.
- **Clean and sanitize** tools, equipment, and work areas regularly.
- **Store potting media** in clean, dry locations off bare ground.
- **Apply fungicides when** conditions are favorable for disease.
- **Rotate fungicides** to reduce resistance risk.

species, was recently discovered in Oregon and Wisconsin nurseries infecting juniper, arborvitae, and false cypress (*Chamaecyparis*) varieties in 2024 and 2025. In addition to these hosts, this pathogen could be a significant threat to other

native and ornamental conifer species from the cypress family including true cypress (*Cupressus*), Nootka cypress, incense cedar, Port Orford cedar, western red-cedar, giant sequoia, and coast redwood.

Initially, *P. austrocedri* was treated as a quarantine pathogen, resulting in significant losses for the affected growers. However, it has since been delisted and is no longer federally regulated, though its exact extent in the U.S. remains unclear. Research has been limited because the pathogen is difficult to isolate and grow in culture. However, early research suggests that this species has a much lower optimal growth temperature than other *Phytophthora* species, growing best between 55–65 F. If the patterns we observed with other species hold true, *P. austrocedri* likely sporulates and causes the most damage within this cooler temperature range.

For Northwest growers, this means the pathogen would most likely be active during the cool, wet weather that dominates from fall through spring. If *P. austrocedri* is a concern, consider applying fungicides during this time period or for as long as conditions remain favorable for infection.

Conclusion

In summary, temperature plays a defining role in *Phytophthora* growth, sporulation, and disease development. Subtle differences between species translate into meaningful seasonal disease patterns with some species preferring warmer temperatures while others prefer cooler temperatures. By aligning fungicide timing and cultural practices with soil temperature thresholds rather than visible symptoms alone, growers can improve disease control and reduce losses. ©

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