Soilborne diseases of nursery crops

USDA-ARS and OSU team up to tackle this pernicious problem

Rhododendron root rot in container production. This plant is just beginning to wilt and the leaves have turned yellowish-green. Both symptoms are typical of plants with root rot.

By Jerry Weiland, Carolyn Scagel, Nik Grunwald, Val Fieland, Zach Foster, Luisa Santamaria and Gilbert Uribe

Recently, the Horticultural Crops Research Laboratory (USDA-ARS) and Oregon State University received funding from the Floriculture and Nursery Research Initiative to study the interaction of soilborne diseases and environment (irrigation, nutrient cycling and soil factors) on nursery plant health.

The objectives of our study include:

1. Identifying the most common soilborne plant pathogens in commercial nursery production systems, including *Pythium*, *Phytophthora* and *Verticillium* species;
2. Developing assays that growers can use to detect the most common soilborne plant pathogens;
3. Evaluating methods of disease control; and
4. Characterizing the roles that soil fungi play in nutrient cycling and soil health.

Our research team included experts in nursery production, soilborne plant pathogens, mycorrhizae, plant physiology and extension services. Together, we hope to improve disease management and soil health for nursery production in the Pacific Northwest.

The project's initial focus was on the soilborne diseases that impact rhododendron production. Rhododendron species and cultivars are a common crop here in the Pacific Northwest ▶

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nursery industry, and by studying the soilborne diseases that affect this crop plant, we hoped to maximize the potential that our research results and pathogen assays will be useful to a large number of regional growers.

In 2013 and 2014, we surveyed seven cooperating nurseries involved in rhododendron production. These nurseries encompassed everything from the initial propagation stage with recently rooted cuttings to 1–3-year-old plants in both container and field production sites. In each nursery, we only sampled diseased plants and attempted to isolate pathogens from the roots and lower stem using culture-based methods (for instance, trying to grow the pathogen out of diseased tissues in petri plates).

Progression of rhododendron root rot symptoms in a field planting. Clockwise from upper left: healthy plant, stunted plant, plant exhibiting wilt and chlorosis, dead plant.

Preliminary survey findings indicated that *Phytophthora* (*Ph.*) and *Pythium* (*Py.*) species are the most common soilborne pathogens causing disease in all stages of rhododendron production. Of the 12 different pathogen species found to date, *Ph. cinnamomi*, *Ph. plurivora* and *Py. cryptoirregulare* are the three most frequently encountered on diseased plants with root rot. All three pathogens are known for having wide host ranges. They are capable of infecting many plant species grown in the nursery trade, including trees and shrubs, annual and perennial flowers, vegetables and fruits.

For 2015, we have a number of experiments planned or already underway. These include:

- Microbiome analysis to identify pathogenic and beneficial microorganisms;
- Fungicide and gypsum efficacy for disease control; and
- Effects of pathogen and irrigation on disease development.

Microbiome analysis

Microbiome analysis involves the identification of a large number of microbes from collected plant or soil samples by using a specific DNA barcode and sequencing technologies, which can sequence barcoded samples with very high throughput.

Basically, all the DNA from a plant and/or soil sample, including the DNA from all of the microbes associated with that sample, is extracted and then barcodes are amplified and sequenced to identify the fungi and bacteria that occur on the plant or in the soil. This is a powerful approach for identifying the microbes associated with nursery crop plants because it does not rely on culturing living microbes from the sample, and it can be used to identify many microbial species at once.

Many of the microbes that are associated with plants are not capable of being cultured (they cannot be grown in petri plates), or they are difficult to culture and often evade detection using traditional methods.

The microbiome approach bypasses culturing the microbes from plant samples and bases identification solely on the DNA isolated from the plant or soil

sample. In this way, we can identify not only the soilborne plant pathogens associated with nursery crops, but we will also be able to identify mycorrhizal and other beneficial fungal species that may help reduce root disease. This will give us a much broader perspective on the fungi and bacteria associated with nursery plants than the culture-based isolation method described above.

Our objective with this research is to identify both pathogenic and beneficial fungi, including oomycetes such as *Pythium* and *Phytophthora*, and bacteria associated with crop plants of the nursery industry. Results will be used to determine which pathogens are the most common in the industry (independent of culture-based methods) and whether beneficial fungi are also present. Currently, we have collected root and soil samples from five rhododendron nurseries representing both field- and container-grown plants, and are beginning analyses to determine which fungal and oomycete species are prevalent.

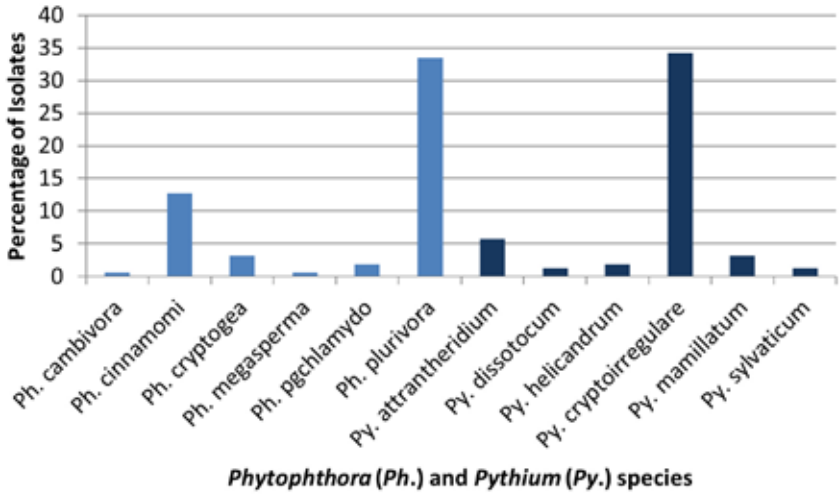
Fungicide and gypsum efficacy

Rhododendron growers do not know the economic risks associated with *Ph. cinnamomi* and *Ph. plurivora* in their nurseries, and there is little information about disease control treatments that are effective for managing these pathogens.

In addition to the direct losses associated with infected plants, diseased nursery stock may also face export restrictions to other states and/or countries. Maryland, for example, recently reported that *Phytophthora* species were isolated from nursery plants received from West Coast suppliers. The report highlighted the pathways by which pathogens can be moved from region to region, on plants and in potting media, and emphasized the importance of practices that reduce or eliminate pathogen spread, such as the use of fungicides or soil amendments to reduce pathogen infection.

Two fungicides, mefenoxam and phosphorous acid, are commonly used in the industry against *Phytophthora* root rot, and gypsum soil amendments have proven effective in controlling *Ph. cinnamomi* root rot of avocado trees in California. However, it is unknown how effective these disease control treatments are against *Ph. plurivora*, a relatively newly discovered *Phytophthora* species in western nurseries. Therefore, the purpose of this research will be to determine which of the three disease control treatments are more effective in managing *Phytophthora* root rot.

The results from the study will be used to establish guidelines for developing and implementing disease control strategies for rhododendron growers. Furthermore, the results will be appli- ▶



Common soilborne pathogens causing root rot in rhododendron nurseries.

cable to growers across a broad range of nursery crop species, because both pathogens are known for their ability to infect a wide range of other plant hosts, including *Cornus* (dogwood), *Pieris* (pieris), *Ilex* (holly) and *Quercus* (oak).

Of pathogens and irrigation

To date, we have identified three common pathogens in rhododendron production: *Ph. cinnamomi*, *Ph. plurivora* and *Py. cryptoirregulare*.

We know that *Ph. cinnamomi* causes significant damage to rhododendrons based on previous research. However, there is little information on how much damage the latter two pathogens can cause in *Rhododendron*.

We also know that irrigation frequency can affect infection by *Phytophthora* and *Pythium* species. Generally, greater water availability increases infection frequency and disease severity. Pathogen susceptibility is often assessed under conditions of optimal water availability, which rarely exist in commercial production systems. Understanding how water availability influences root rot will aid in developing irrigation practices that optimize water use while maintaining or enhancing stock quality and minimizing disease development. As competition for irrigation water increases, management practices that promote plant health as well as water-use efficiency are an important priority throughout the nursery industry.

This year, container experiments will be initiated to determine the effects of inoculum level (low versus high amount of pathogen in soil) of *Ph. cinnamomi*, *Ph. plurivora* and *Py. cryptoirregulare* and irrigation treatment (frequency, timing and volume) on disease development and growth of *Rhododendron*.

We just completed one trial this April and preliminary results indicated that both *Ph. cinnamomi* and *Ph. plurivora* cause much more damage than *Py. cryptoirregulare*. We also found that infection and disease severity increases as the amount of the pathogen in the soil increases. Results from this study will allow us to determine the risk associated with each pathogen and to establish damage thresholds based on soil pathogen populations.

Results from our upcoming irrigation studies will be helpful in understanding how nursery irrigation practices exacerbate disease and will provide growers a basis for developing cultural management strategies to mitigate root rot.

Summary

Soilborne diseases are a common problem in nursery production. By focusing initially on identifying pathogens with both culture-based and microbiome analysis, we will determine which pathogens are the most common in the industry.

Based on initial results that found *Ph. cinnamomi* and *Ph. plurivora* at a number of nurseries, we designed a research study for 2015 to evaluate disease control treatments for controlling root rot. Further studies are also in the works to determine how irrigation influences disease development.

Initially, we chose to concentrate our research on *Rhododendron*, a popular and widespread nursery crop in the region, but we plan to broaden our research to include other plant species in the future. With the knowledge we will gain from this research, we can reduce the impact soilborne diseases have in nursery production.

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