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Oregon State UNIVERSITY **OSU**

AN ONGOING STUDY EVALUATES
THE SYSTEMS APPROACH FOR
MANAGING *PHYTOPHTHORA*

DISEASES IN NURSERIES

*By Jennifer Parke, Carrie Lewis,
and Niklaus Grunwald*

Almost every nursery grower is familiar with the plant pathogen *Phytophthora* (from the Greek, meaning “plant destroyer”). *Phytophthora* species cause some of the most damaging nursery crop diseases nationwide, including root rot, dieback, leaf blight (see photo at left) and shoot blight.

These pathogens do more than cause crop losses in nurseries. They reduce plant quality and undermine customer confidence in nursery products. Some species, such as the non-native

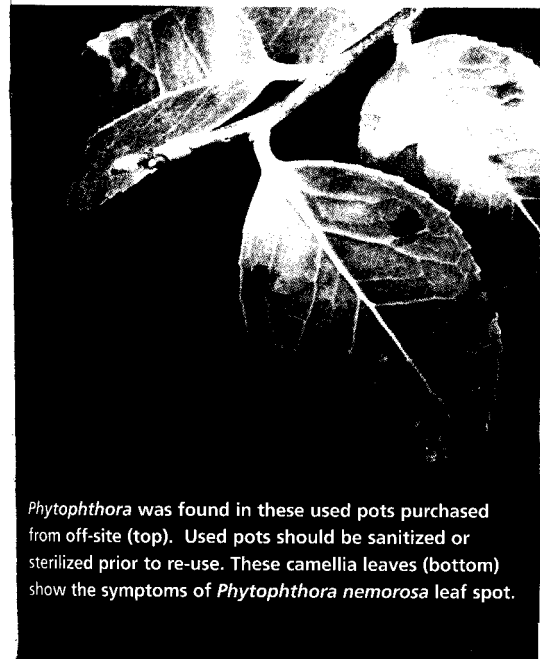
pathogens *Phytophthora ramorum*, *P. kernoviae*, or *P. alnus*, can cause serious diseases of forest trees. Nursery plants can serve as long-distance carriers of these forest pathogens.

Nurseries infested with *P. ramorum*, a quarantine pathogen, also must bear significant economic losses associated with crop destruction, eradication treatment, and lost sales.

Is there a better way to manage processes to reduce this risk?

Although nursery plants are inspected before they are issued a phytosanitary certificate for interstate shipping, it is difficult to detect microscopic pathogens. This is especially true if plants have only recently become infected and symptoms are not apparent.

Root diseases are notoriously difficult to detect in the early stages. Traditional,



Phytophthora was found in these used pots purchased from off-site (top). Used pots should be sanitized or sterilized prior to re-use. These camellia leaves (bottom) show the symptoms of *Phytophthora nemorosa* leaf spot.

single "end point" inspections may miss infected plants, resulting in disease spread across the United States and to other countries. Moreover, if infested plants are found, the grower may not know how to correct the problem, since the pathogen

could have been introduced at any stage of the production cycle.

The 'systems approach'

Our team engaged in research aimed at evaluating a different strat-

egy for ensuring the health of nursery plants and preventing the shipment of diseases across the country.

In a study funded by the USDA-ARS Nursery and Floriculture Initiative, with additional contributions from the USDA- Forest Service and The Nature Conservancy, we are using a systems approach to determine sources of contamination in nurseries. This approach is modeled after the HACCP (Hazard Analysis of Critical Control Points) strategy in use by the food industry to ensure that foods do not become contaminated during processing.

The U.S. Fish and Wildlife Service also uses a modified HACCP approach to make sure that undesirable species such as aquatic weeds, mollusks, and fish parasites are not inadvertently released when they stock lakes and rivers with fish.

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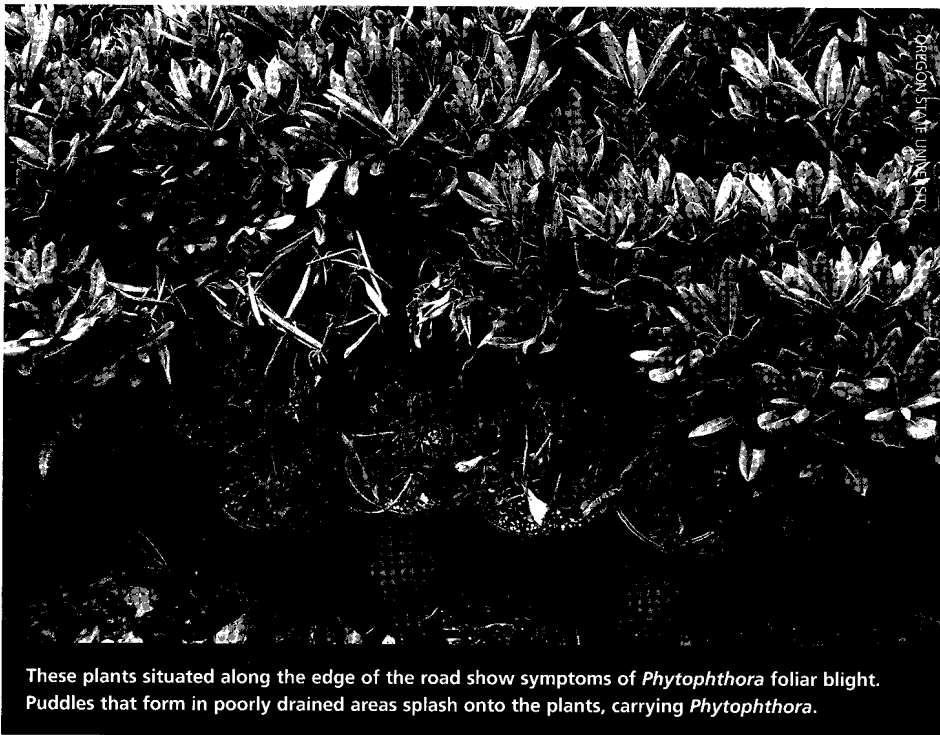
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These plants situated along the edge of the road show symptoms of *Phytophthora* foliar blight. Puddles that form in poorly drained areas splash onto the plants, carrying *Phytophthora*.

In our systems approach research, we examine a nursery's entire production system to determine where *Phytophthora* is, in order to determine how it is getting there and how we can get rid of it. Our goal has been to identify Critical Control Points (CCPs) in the production system – that is, points at which a *significant hazard* of contamination can be controlled.

Although the approach could be applied to any pest or disease, *Phytophthora* makes a good model for this study because the genus includes waterborne, soilborne, and airborne pathogens. If these sources of *Phytophthora* are eliminated, it is likely that many other pathogens will also be reduced.

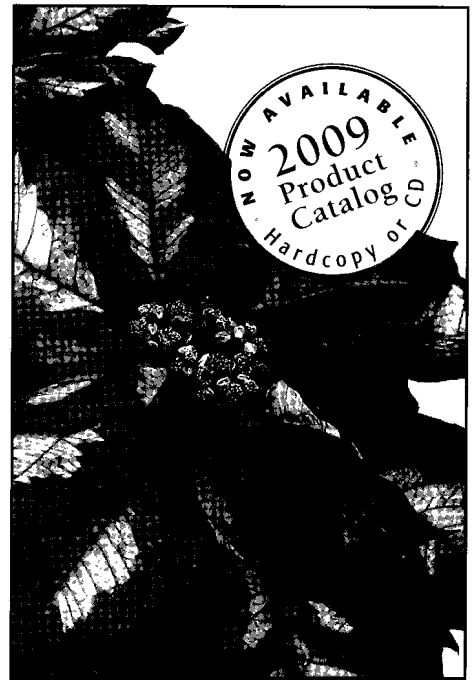
The experiment is designed to determine the CCPs for each nursery and to compare *Phytophthora* detection before and after implementation of mitigation procedures. The first 18 months were spent developing base line data for each of the nurseries. We then reported our findings to each of the nurseries and brainstormed with the growers to develop mitigation procedures.

During the final year of the study, which ends in August 2009, we will determine if the mitigation procedures make a difference in the recovery from *Phytophthora*.

We are working with four cooperating nurseries, including one small, two mediums, and one large wholesale nursery. We refer to them as nursery A, B, C, and D to protect their anonymity. Each nursery has both container and field production. All of these nurseries propagate their own plant material on-site, eliminating the possibility of acquiring plant diseases with purchased plant material.

The first step in determining the CCPs was to develop a production flow chart and a sampling strategy for each nursery. We sampled each nursery six times each year, focusing initially on *Rhododendron*, *Pieris*, *Kalmia*, and *Viburnum*. We later broadened the study to all symptomatic hosts.

Each time we visited the nursery, we collected plants from each location and stage of production. To see if *Phytophthora* was present in



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the plant tissue, we excised small pieces of roots, shoots, and leaves and placed them onto special nutrient agar in Petri dishes to allow the growth of *Phytophthora*. We also sampled potting media and potting media components, containers, greenhouse propagation benches, soil and gravel substrates in greenhouses, can yards, and fields, water used for irrigation, including water from irrigation ponds, recycled water, and water from overhead sprinklers.

We used *Rhododendron* leaves in water to "bait" *Phytophthora* from these sources. The leaf baits were then cut up and plated onto Petri dishes to allow growth of *Phytophthora*. Unfortunately, some other water molds (*Pythium* spp.) and fungi can also grow on this special agar medium. Of the 4,355 cultures we obtained from

the nurseries in the first 18 months, only 820 were *Phytophthora*.

While it is interesting to know where *Phytophthora* was present in the nursery, it also is important to know which species they are. This will help us understand the pathways by which contamination occurs and allow us to take steps to eliminate them.

Phytophthora species differ in their biology and ecology. For example, *P. syringae*, often associated with contaminated leafy debris, causes foliar infections and is active mainly in the winter months, whereas *P. cinnamomi*, a soilborne species, prefers warmer temperatures and mainly infects roots. *Phytophthora* species identification was an important but labor-intensive aspect of this study.

We first used an ELISA lab procedure to determine which isolates

belonged to the genus *Phytophthora*. *Phytophthora* isolates were further identified to species by sequencing their DNA and finding their closest match to known species in a worldwide database.

Findings to date

While the study will not be complete for another year, we have determined the CCPs for each of the nurseries and learned some interesting and surprising results.

Nursery A

The CCPs in this nursery include the use of contaminated water for irrigation, contamination of potting media by field equipment, contamination of container plants by setting them on

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SYSTEMS

infested soil in greenhouses, reuse of contaminated pots, and inadequate drainage in the field. *P. cinnamomi* was the major contaminant in this nursery. Pots are reused on-site without sanitizing them, and additional dirty pots are purchased from off-site (See photo, Page 43). *P. citrophthora* was found in these re-used pots.

Although the potting medium ingredients were initially free of *Phytophthora*, the piles became contaminated when the mixing area flooded during rain events and when field equipment was used to mix and load it.

This nursery uses a combination of well water, river water, and recycled water from a holding pond. Although the recycled water is normally treated with sodium hypochlorite solution, occasional lapses in water treatment resulted in recovery of *P. gonapodyides*, *P. citrophthora*, *P. cryptogea*, and some unidentified *Phytophthora* species from the water and the sprinkler heads.

Container plants were often set directly on field soil where splash dispersal from mud puddles resulted in plant disease. Specific recommendations to the grower included increased sanitation practices and improvements in water management.

Nursery B

The CCPs in Nursery B were infested leafy debris, contaminated field soil and gravel substrates in greenhouses, dirty pots, and poor drainage.

In this nursery, accumulations of leafy debris over time resulted in poorly draining gravel substrates in greenhouses and can yards (see photo, Page 51). Puddling of water in these areas led to the spread of disease. Poor drainage in one particular field caused a severe spread of *P. cinnamomi* throughout the entire field. In an effort to increase can yard space, blocks of container plants are held on bare soil. Irrigation water was not a source of contamination in this nursery, since well water is used.

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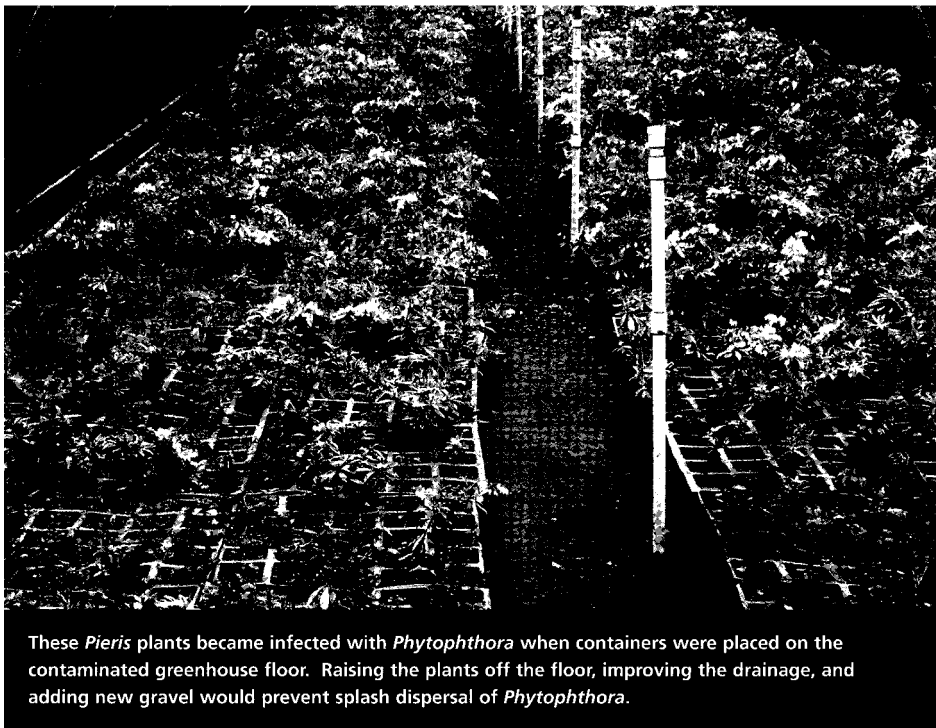
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These *Pieris* plants became infected with *Phytophthora* when containers were placed on the contaminated greenhouse floor. Raising the plants off the floor, improving the drainage, and adding new gravel would prevent splash dispersal of *Phytophthora*.

As in Nursery A, *P. cinnamomi* was the most prevalent species found in this nursery, although *P. citrophthora*, *P. cryptogea*, and *P. megasperma* were also found. Specific recommendations to the grower included increased sanitation practices, sterilization of used containers or purchase of new ones, and improvements in water management.

Nursery C

The CCPs in Nursery C were contaminated pots, can yard substrates, and field soil, recycled irrigation water and, on one occasion, contaminated potting medium. *P. citrophthora* and *P. cryptogea* were isolated at low frequencies in can yard substrates and in field soil. Container media from plants in greenhouses were infested with *P. citricola* and other *Phytophthora* species but the greatest source of contamination was from infected plants that were brought into the greenhouse, leading to disease spread via irrigation and water splashing. *P. cryptogea* was found in pots intended for re-use.

This nursery keeps all its potting media components on a concrete pad and uses dedicated mixing equipment.

The potting medium finding was from a pile located outside the usual potting area and traced to non-treated recycled irrigation water used to wet the pile. Recycled irrigation water was consistently contaminated with *P. cryptogea*, *P. gonapodyides* and other unidentified *Phytophthora* species. This water was used to irrigate portions of the nursery, including plants on the loading dock, but with the recent addition of a chlorine injection system, irrigation water is now testing negative for *Phytophthora*.

In general, the *Phytophthora* contamination was at a very low frequency in this nursery and overall they are doing an excellent job in managing water and sanitation. Specific recommendations to the grower included increasing sanitation practices, sterilizing used containers or purchasing new ones, and implementing a treatment system for recycled irrigation water.

Nursery D

The CCPs in Nursery D are contaminated potting media components,

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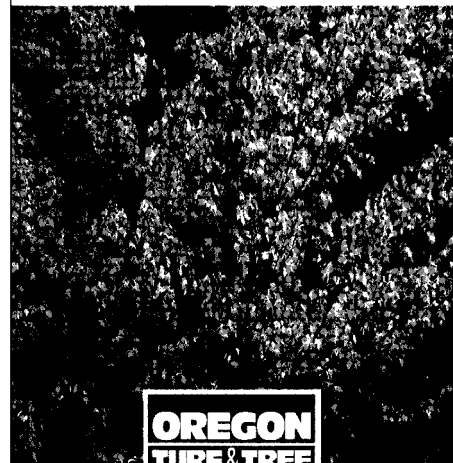
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used containers, and greenhouse and can yard substrates. This nursery uses river sand as a component in their potting medium mix and it was contaminated with *P. gonapodyides*. *Phytophthora* was consistently detected in pots intended for re-use.

In this nursery, accumulations of leafy debris over time resulted in poorly draining gravel substrates in greenhouses and can yards. *P. syringae* (on *Kalmia*) and *P. citricola* (on *Rhododendron*) were causing significant foliar disease in container plants and *P. cryptogea* was also found in association with soil substrate.

Water management is a challenge for this grower due to the sloping site that channeled water into greenhouses. Poor drainage near the entrance of buildings created opportunities for *Phytophthora* to be tracked in on the shoes of workers.

Specific recommendations to the grower included increased sanitation practices including adding a sanitizing foot bath, sterilizing used containers or purchasing new ones, and improving drainage.

Clean up of the leafy debris from *P. syringae* infection of *kalmia* foliage was deemed important for preventing the recurrence of this disease in a can yard. The grower suggested picking up the leafy debris with a riding mower and bag attachment in between container crops, and this is working very well.

Conclusions

Although the study is still underway, the systems approach has already been effective in identifying sources of *Phytophthora* contamination in nurseries and advising growers on management practices that will reduce disease.

Irrigation water and field soil were previously known sources of *Phytophthora*, but this study revealed that dirty pots designated for re-use can harbor *Phytophthora* species. This could be especially important when

dirty pots are brought in from other nurseries.

We need to increase grower awareness about the importance of sanitizing pots before re-use. Plants consistently became contaminated after placing them on clogged gravel substrates in the greenhouse or can yard. Research is needed to establish effective ways to eliminate this source of contamination.

This work also highlighted the fact that best management practices for sanitation of water are not well established and that data for acceptable minimal thresholds of *Phytophthora* contamination in recycled water are nonexistent.

Irrigation water can be sanitized by use of chlorine, bromine, or UV treatment, but also filtering using either mechanical or biofilters. These alternate practices might also be useful in reducing pesticide and nutrient loads in irrigation water simultaneously addressing other important environmental concerns.

Brainstorming with growers about the sources of contamination in their nurseries has been key to the success of the program. While scientists may understand where the pathogen is coming from, growers familiar with their operation provide creative insights for problem solving. For example, use of the riding mower to clean up leafy debris is a simple solution but it would not have occurred to us.

The systems approach could be applied to more pathogens and pests in domestic nurseries. It could also be applied to offshore nurseries to ensure health of imported "plants for planting" to prevent future introduction of pests and pathogens into the U.S.

Growers from the cooperating nurseries have been enthusiastic about the systems approach program. As one cooperator noted, "We used to dread inspections, but now we look forward to them. Participating in this program has really changed our attitude. Over time we've become comfortable with

someone else looking at our operation and it helps to keep us on our toes. Now we feel more confident and are much more proactive. When we see something we deal with it right away before it becomes a problem. We want to continue to participate with OSU and want them to conduct more research here at our nursery – it's been very helpful to us. All of the information they've shared with us has helped us do a better job of growing our plants."

"Using new pots gave us some unexpected benefits," said another grower. "Besides having less disease than when we re-used pots, we have fewer weeds, so we are able to save on herbicide and labor costs."

"In just two seasons, I have seen the benefits of the changes we've implemented as a result of this program," said another grower.

The Oregon Dept. of Agriculture, along with 23 cooperating nurseries, has used our findings on CCPs as a basis for implementing the Grower Assisted Inspection Program (GAIP). Participating nurseries have developed their own mitigation manuals to address how they are preventing *Phytophthora* contamination from irrigation water, contaminated soil and substrate, dirty pots, and plant purchases from other nurseries.

For further information on this program, contact Gary McAninch, Nursery and Christmas Tree Program, or Melissa Lujan, GAIP auditor, at ODA.

Acknowledgements

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