Determining the Efficacy of a Systems Approach for Producing Nursery Stock Free of Plant Pathogenic Phytophthora species

PRINCIPAL INVESTIGATORS:
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PROJECT OBJECTIVES:

1. To develop, implement, and evaluate a systems approach for producing nursery stock free of plant pathogenic *Phytophthora* species,
2. To apply the systems approach to determine critical control points for *Phytophthora* contamination in nurseries, and
3. To determine *Phytophthora* species distributions associated with each critical control point.

ACCOMPLISHMENTS:

Phytophthora species threaten the health of forests and human landscapes, causing economic hardships for nurseries due to loss of sales, regulatory restrictions, and destruction of infested crops. We developed a new approach for producing nursery stock free of *Phytophthora* that could also be applied to other pests and pathogens. We adapted the Hazard Analysis Critical Control Point (HACCP) strategy used in the food processing industry to identify Critical Control Points (CCP) for *Phytophthora* contamination in the nursery production cycle. A CCP is the best point at which significant hazards of contamination can be prevented.

Four Critical Control Points (CCPs) were identified: infested soil/gravel substrates, irrigation water, re-used pots, and potting media that has been contaminated by field equipment. The most common source of contamination in all tested nurseries was infested soil/gravel substrate in greenhouses and can yards. Healthy container plants set on these substrates readily became contaminated. We consistently recovered *Phytophthora* from recycled irrigation water and from containers designated for reuse. Our recommendations highlight the need to improve sanitation practices to target these sources of contamination in nurseries.

A total of 674 *Phytophthora* isolates was recovered from Oregon nurseries including 15 *Phytophthora* species and 7 other *Phytophthora* taxa. The most frequently isolated species from symptomatic plants were *P. citricola*, *P. cinnamomi*, and *P. syringae*. From gravel substrates, soil, and used containers, the predominant species were *P. citricola*, *P. cinnamomi*, and *P. cryptogea*. From irrigation ponds, most isolates were *P. gonapodyides* or other *Phytophthora* taxa belonging to ITS Clade 6. *P. parsiana*, not previously reported from nurseries, was also detected. *P. cinnamomi*, the species most frequently isolated from plants, was never recovered from water. *Phytophthora* species recovered from specific CCPs differed among nurseries, likely a reflection of different production practices and composition of plant cultivars.

To our knowledge, this is the first time a systems approach has been applied to determine sources of contamination in plant production systems. It will provide a basis for considering alternatives to the current system of end-point nursery stock inspections, and will guide in the development of targeted mitigation strategies. A novel and highly successful component of the

project was the interaction between scientists and growers that resulted in development of science-based *and practical* Best Management Practices.

TECHNOLOGY TRANSFER/IMPACT:
Our findings on the frequency of *Phytophthora* recovery at specific CCPs have convinced growers to improve sanitation practices and implement effective mitigation strategies for controlling disease in their nurseries. For example, many growers have initiated water decontamination systems and developed the capacity to treat their used containers with aerated steam. Several new business enterprises have been initiated to address the need to sanitize containers. Improved sanitation practices are resulting not only in less *Phytophthora* disease, but in better plant growth generally and reduced weed problems.

Results of this work are being shared with the nursery industry, state and Federal regulatory agencies, and the scientific community. This includes three poster presentations and four oral presentations at regional, national, and international meetings (Western Disease Conference, Western Horticulture Inspectors Meeting, Ornamentals Workshop, Sudden Oak Death Science Symposium, American Phytopathological Society, International IPM); a feature article in the nursery trade publication Digger (circulation = 8,000); a talk at a workshop for regional and national regulatory officials and nursery industry representatives; and three scientific manuscripts (in preparation).

Results are also being disseminated to the nursery industry nationally in the *Phytophthora* Online Course: Training for Nursery Growers (www.ecampus.oregonstate.edu/phytophthora), a course that we helped develop. This course teaches nursery personnel about the biology, symptoms, and cultural control of *Phytophthora* so that they can manage these diseases more knowledgeably and effectively. Both English and Spanish versions are available.

Our results highlighting the four Critical Control Points for *Phytophthora* contamination provided the scientific basis for a new statewide program, the Grower-Assisted Inspection Program (GAIP) by the Oregon Department of Agriculture. The 23 GAIP nurseries receive special certification designating them as free from *Phytophthora ramorum*. This program is serving as a model for other state and national regulatory programs aimed at finding effective alternatives to end-point nursery inspections.

The systems approach has been very successful for identifying Critical Control Points for *Phytophthora* contamination in the nursery production system and could readily be broadened to include additional pathogens and pests. Such an approach has significant potential in identifying sources of contamination, targeting mitigation strategies, providing a scientific basis for development of Best Management Practices, and providing an alternative strategy for inspecting nursery crops to reduce spread of pests and diseases with nursery stock.

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