

Phytosanitation: A Systematic Approach to Disease Prevention

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Landis TD. 2013. Phytosanitation: a systematic approach to disease prevention. In: Haase DL, Pinto JR, Wilkinson KM, technical coordinators. National Proceedings: Forest and Conservation Nursery Associations—2012. Fort Collins (CO): USDA Forest Service, Rocky Mountain Research Station. Proceedings RMRS-P-69. 97-101. Available at: http://www.fs.fed.us/rm/pubs/rmrs_p069.html

Abstract: Phytosanitation is not a new concept but has received renewed attention due to the increasing threat of nursery spread *Phytophthora ramorum* (PRAM), the fungus-like pathogen that causes Sudden Oak Death. This disease has the potential to become the most serious forest pest since white pine blister rust and chestnut blight. Phytosanitation can help prevent the spread of this and other pathogens to or from nursery operations. Phytosanitation can most simply be viewed as an input-output model: prevent pests from entering your nursery and make certain that your plants are not carrying pests when they leave your nursery for sale or outplanting. Two major approaches to phytosanitation can be employed. The systems approach is based on a Hazard Analysis of Critical Control Points and comprehensive programs that have been developed for ornamental nurseries can easily be modified for forest, conservation, and native plant facilities. A second approach based on target pests might be easier for smaller nurseries with limited funds and manpower. Here, the idea is to learn as much as possible about pests that are found in your nursery or ones, like *Phytophthora ramorum*, that could threaten it. By focusing on the type of pest and its methods of spread, nurseries can adapt their scouting and cultural practices to minimize adverse affects. Because their stock is outplanted directly into forests and other wildland plant communities, nursery managers should be especially vigilant to make sure that PRAM isn't spread to or from their operation.

Keywords: nursery, forest, native plant, seedling, *Phytophthora ramorum* (PRAM)

Introduction

A good working definition of phytosanitation is “concerning the health of plants; especially the freedom from pests requiring quarantine” (Wiktionary 2012). So, phytosanitation is similar to integrated pest management but is especially concerned with nursery pests that are subject to quarantine regulations. A nursery pest can be defined as any biological stress factor that interferes with healthy seedling development and causes a sustained departure from the normal physiological or morphological condition that characterizes a healthy plant (Dumroese 2012). The most common nursery pests are microorganisms such as fungi and bacteria but insects and weeds also fit this definition (Landis and others 1990). So, a working definition of phytosanitation means that you work to prevent pests from entering your nursery, as well as ensure that your nursery stock isn't infected or infested when it leaves your nursery (Figure 1).

Phytosanitation is not a new concept, but has been discussed for over 50 years in ornamental nurseries. The subtitle of The U.C.

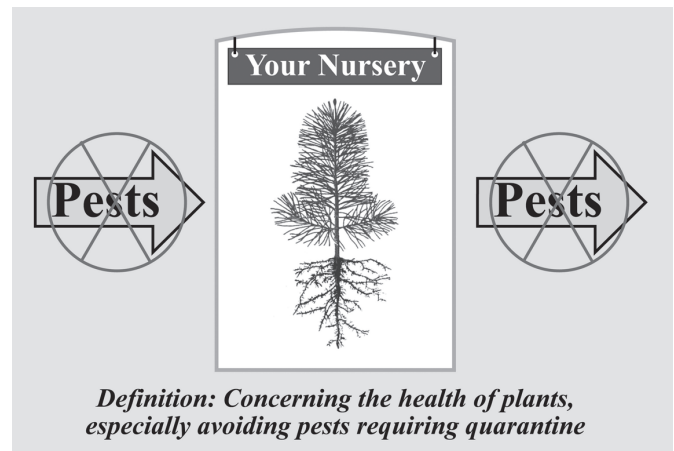


Figure 1. Phytosanitation means that you prevent pests from entering your nursery as well as make certain that your plants are not carrying pests when they leave your nursery for sale or outplanting.

System for Healthy Container-Grown Plants (Baker 1957) was “Through the Use of Clean Soil, Clean Stock, and Sanitation.” This classic nursery manual introduced steam sterilization of soils and the development of artificial growing media as a way to prevent the introduction of damping-off and other root diseases in container nurseries.

In the United States, phytosanitary inspections are regulated by the Plant Protection and Quarantine (PPQ) program of the Animal and Plant Health Inspection Service (APHIS), US Department of Agriculture (USDA 2012), but individual states can also impose phytosanitary restrictions. The current interest in phytosanitation was stimulated by the sudden oak death (SOD) disease which is caused by the fungus-like pathogen *Phytophthora ramorum* (PRAM).

The Systems Approach to Phytosanitation

The PRAM situation in California, Oregon and Washington has focused renewed interest in developing phytosanitation programs for ornamental nurseries (Parke and Grunwald 2012; Griesbach and others 2011). Because of problems with contaminated food back in the 1970’s, the US Food and Drug Administration developed a systematic approach called Hazard Analysis of Critical Control Points (HACCP). A control point is any step in a production system that can be measured, monitored, controlled, and corrected, and a critical control point is the best step at which significant hazards can be prevented or reduced. The HACCP system consists of a series of logical steps to identify, evaluate, and correct sources of hazards (USFDA 2012).

The HACCP approach has been developed to prevent the spread of pests and diseases in ornamental nurseries in Oregon (Parke and Grunwald 2012). The Oregon Association of Nurseries has recently published the “Safe Procurement and Production Manual: a Systems Approach for the Production of Healthy Nursery Stock” (Griebasch and others 2011). This comprehensive guide integrates HACCP principles into system approach and, although some of the production systems are different, the same basic concepts can be applied to forest and na-

tive plant nurseries. A free PDF version is available online at website: (<http://www.science.oregonstate.edu/bpp/labs/grunwald/publications/SafeProduction.pdf>), or a print version is available from the OAN office, 503-682-5089 or 800-342-6401.

The first step is to view your nursery in terms of production systems, and then to identify the control points and critical control points (CCP) in each system. For example in a container nursery, the sowing operation consists of a series of consecutive steps which can be analyzed for their potential to spread diseases and pests. The steps at which hazards can be reduced or eliminated are your critical control points for the sowing operation (Figure 2A). For example, we know that fungal spores or weed seeds can be introduced in growing media, so the components should be tested and then pasteurized if necessary. Likewise, fungal spores can be introduced from soil or root fragments so used containers should be washed and sterilized. The last CCP in this operation are the seeds. The spores of pathogenic fungi, such as a *Fusarium* spp., have been proven to be carried into nurseries on seedcoats of conifer seeds (Figure 2B). Large and rough textured seeds are particularly susceptible so seed samples should be tested and cleansed before sowing. A “running water rinse” has been shown to be very effective in this regard, a quick soak in a dilute bleach solution also works (Figure 2C).

A good bareroot nursery example where the HACCP process can be applied is the transplanting operation, where there are 2 CCPs (Figure 3A). Many nurseries either purchase seedlings for transplanting from other nurseries or obtain them from a customer. The introduction of transplants has been shown to be a significant risk for introducing pests, especially root rot fungi, into the transplant nursery (Figure 3B). The major problem is when bareroot seedlings are transplanted into another nursery (Cram and Hansen 2012); the risk of spreading root disease on container transplants is much less. Root rot fungi and nematodes can also be introduced into a bareroot nursery on cultivation or transplanting equipment. For this reason, savvy nursery managers insist that operators clean and sterilize their equipment (Figure 3C) when it is moved from one field to another, and especially when equipment is leased or borrowed from other nurseries.

Once you have analyzed all your production systems then the final step is to develop Best Management Practices that address the potential problems at each CCP.

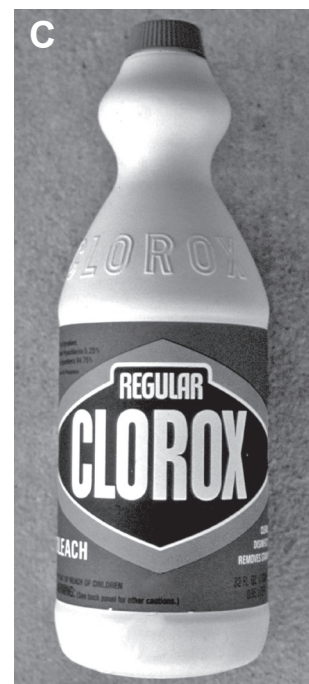
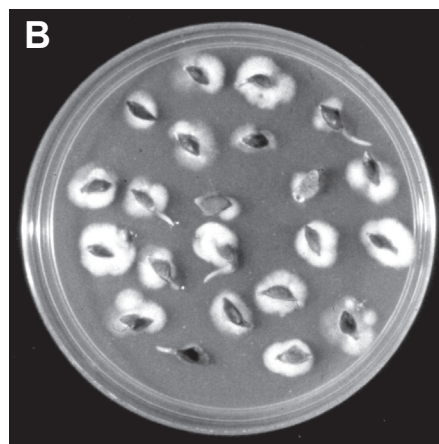
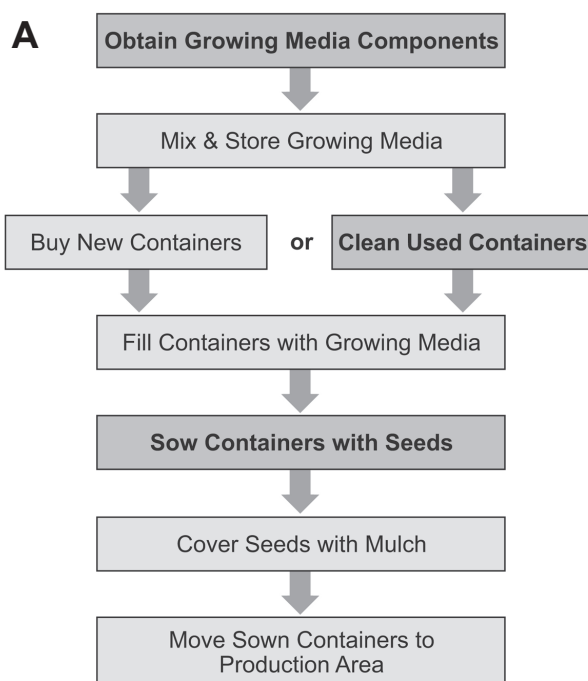


Figure 2. A hazard analysis of each step in a container sowing operation identifies critical control points (boxes with bold text and dark shading) where pests can enter your nursery (A). For example, fungal spores carried on seedcoats (B) can be eliminated by quick soak in a dilute (1 bleach:10 water) bleach solution (C).

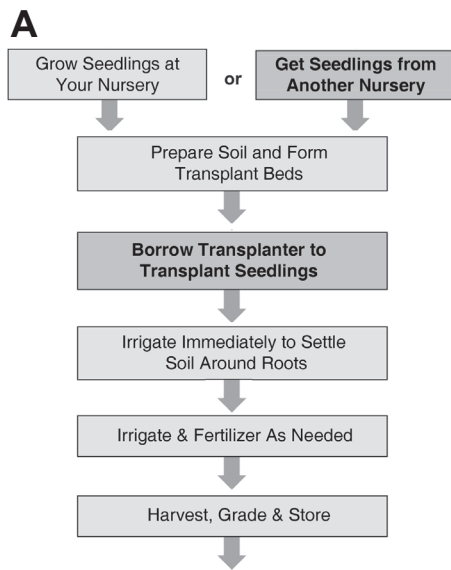


Figure 3. Root rots can easily be introduced into your nursery during transplanting so a hazard analysis should examine each step in the operation (A). The critical control points are when seedlings are purchased from another nursery (B), or when equipment carries infected soil from another location (C).

Phytosanitation Techniques for Specific Target Pests

A simpler yet still effective approach to phytosanitation is to make a list of your most significant nursery pests, and do some research into how they spread. This approach is probably more practical for small nurseries that don't have the funding or manpower to implement the systematic approach. There is a wealth of good information published on nursery pests. For example, *Forest Nursery Pests* (Cram and others 2012) has just been published and contains excellent information on the most common pest problems that you might encounter in your nursery, and well as other useful information on diagnosis and integrated pest management.

1. Damping-Off

This is one of the oldest diseases of forest nursery plants, and affects germinating seeds or just-emerged seedlings before their stems become lignified. Most conifer and broadleaved plants can be affected (James 2012).

Type of Pest:

Several genera of fungi, such as *Fusarium* and *Rhizoctonia*, or Oomycetes including *Pythium*, and *Phytophthora*.

Method of Spread:

Spores on seeds, in soil or growing media, or in water.

Critical Control Points:

Spores can be transmitted in nursery soil or can be introduced on seedcoats. Certain damping-off fungi have motile zoospores which can move in water or wet soil.

Phytosanitary Risk to Your Nursery:

Damping-off is a nursery disease that's been around forever, and nursery managers have to be constantly vigilant. It can easily be controlled, however, by learning how it spreads and taking preventative measures that are well documented (James 2012, Landis and others 1990).

Phytosanitary Risk to Your Customers:

Because damping-off that is only seen during germination and early growth, it would not be carried on healthy nursery stock that are shipped to the field.

2. Grey Mold or Botrytis Blight

Like damping-off, this is a very common nursery disease and can affect most plants grown in nurseries (Haase and Taylor 2012).

Type of Pest:

Botrytis cinerea, a fungus.

Method of Spread:

Aerial spores, or from seedling to seedling.

Critical Control Points:

Botrytis is one of those diseases that seem to come out of nowhere, so it's hard to identify specific control points.

Phytosanitary Risk to Your Nursery:

It would be almost impossible to prevent Botrytis but both research and practical experience have shown that constant vigilance to catch infections early and continuous roguing of diseased plants are effective.

Phytosanitary Risk to Your Customers:

Botrytis is often identified during packing on the senescent foliage of plants that have been grown close together. Because this fungus can spread at temperature above freezing, many nurseries have converted to freezer storage. Otherwise healthy plants with minor infections will not spread the fungus after outplanting as this disease will not survive under drier conditions.

3. Sudden Oak Death

Although this is a relatively new disease that has caused serious damage in forests in the US and Europe, *Phytophthora ramorum* (PRAM) also infects nursery plants as a shoot or leaf blight.

Type of Pest:

PRAM a fungus-like pathogen that produce relatively minor symptoms in nursery stock, but research has shown that it can persist on plant material or even organic matter.

Method of Spread:

This pest produces 3 types of spores: motile zoospores, which can actively disperse in water; chlamydospores, which can survive long periods in plant tissue or even organic matter (Figure 4a); and thick walled oospores that are sexually produced by the combination of two mating types (Chastagner and others 2012).

Critical Control Points:

Due to its many spore types, PRAM has multiple modes of transmission. It is most commonly spread through any type of plant material shared between nurseries including cuttings and transplants. Seed transmission has not been proven so far. Zoospores can spread through any form of water such as rain splash and surface runoff, and has been shown to persist in waterways around nurseries (Chastagner and others 2012).

Phytosanitary Risk to Your Nursery:

The disease potential for this pathogen is extreme. Because over 100 species of trees and shrubs from 36 different families are susceptible (Chastagner and others 2012), PRAM has the potential to

become the most serious forest pest since white pine blister rust and chestnut blight. Although PRAM has only been positively identified on ornamental nursery stock as of the current date, it is only a matter of time until infections are discovered on forest, conservation, and native plant species. Although PRAM has not proven to be a serious nursery disease, it can still have serious economic impacts due to plant quarantine regulations. At one ornamental nursery in Southern California, over 1 million camellias worth \$9 million had to be destroyed because of a PRAM infestation (Alexander 2006). Therefore, nursery managers must become familiar with disease symptoms and keep up-to-date on the latest developments.

Phytosanitary Risk to Your Customers:

Disease symptoms on nursery stock are relatively minor. What's most worrisome is that many infected plants show no visible symptoms at all (Vercauteren & others 2012). Genetic testing has proven that long-range spread can be attributed to the shipping of infected nursery stock, and that PRAM can then be transmitted to surrounding forests (Mascheretti and others 2008). Because they ship their plants directly into forests and other natural settings, forest and native plant nurseries represent a serious transmission threat. Unfortunately, this has already happened in the United Kingdom. In this case, nursery stock has been shown to be the cause of a devastating forest disease outbreak in Japanese larch plantation where 3 million trees have been killed (Brasier 2012).

The PRAM epidemic has resulted in both state and federal quarantine restrictions (Kliejunas 2010). The state of Oregon instituted a quarantine on nursery stock coming from California in 2001, and APHIS issued a federal regulation in 2004 to regulate interstate transportation for PRAM host materials, including nursery stock, from the states of California, Oregon, and Washington. By 2009, more than 68 countries had some quarantine regulations concerning PRAM nursery stock (Sansford and others 2009).

Although little has been published on the effects of PRAM in forest, conservation, and native plant nurseries, a comprehensive article is being written for the Winter 2013 issue of Forest Nursery Notes. The most current information on PRAM can be found on-line at the following websites:

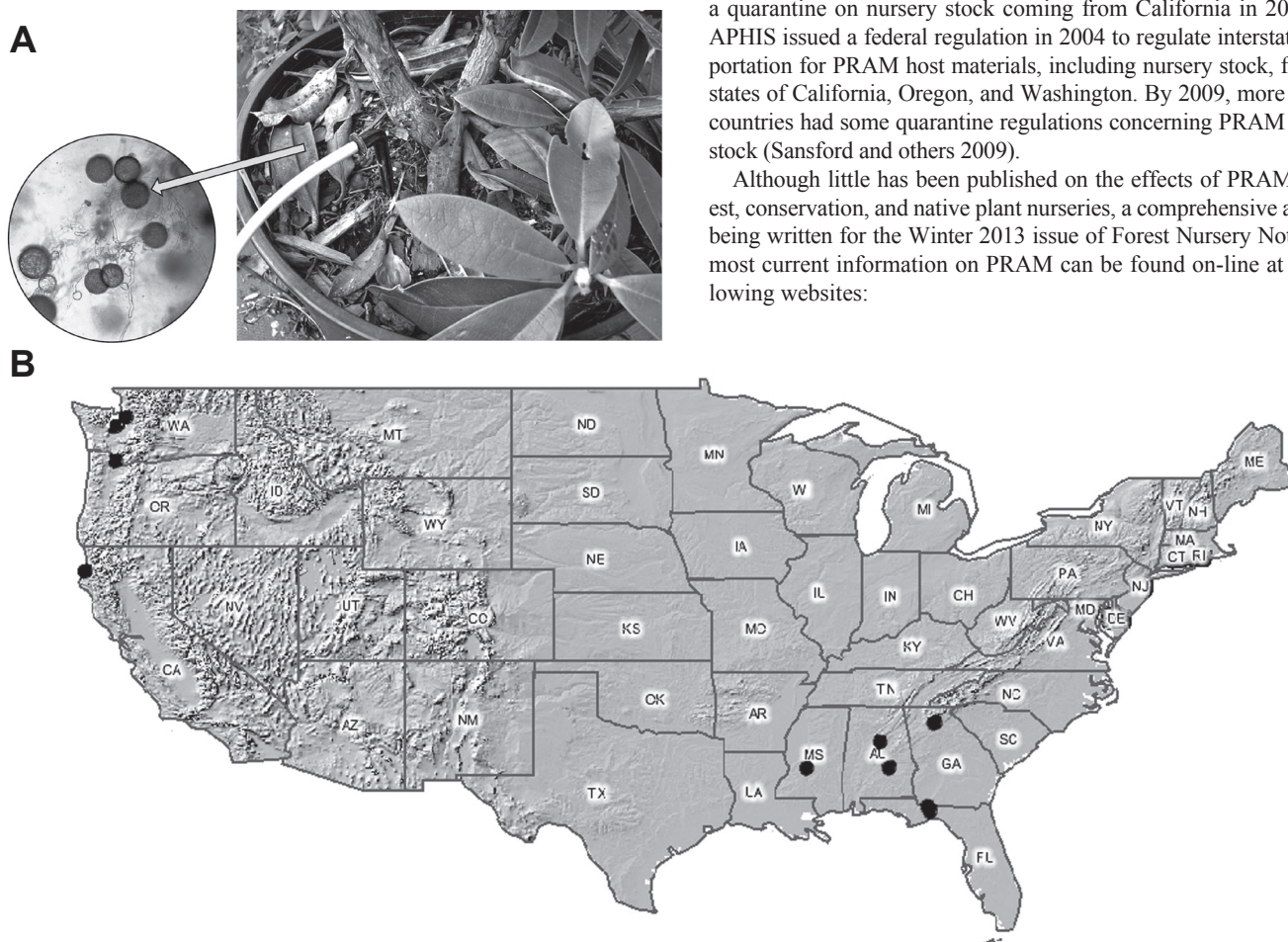


Figure 4. *Phytophthora ramorum* is a new insidious nursery pest because, although nursery symptoms are very minor, it can persist in root systems and leaf litter (A). This fungus-like pest has motile zoospores and can spread in water; this map shows PRAM detected in waterways around nurseries (B). (A from Elliott 2012; B from Chastagner and others 2010)

1. <www.suddenoakdeath.org> - This website contains a section on *Phytophthora ramorum* in nurseries including diagnostic guides. It also has contact information for your local state.

2. <http://www.aphis.usda.gov/plant_health/plant_pest_info/pram/index.shtml> - This APHIS website has a section on *Phytophthora ramorum*/Sudden oak death, which includes the most current host lists and legal information on quarantine restrictions

Summary

Phytosanitation should become a part of your overall nursery management. Due to the increased concern about PRAM, a wealth of recent information on phytosanitary concerns in nurseries is available. Either the systems approach based on Hazard Analysis of Critical Control Points or, for smaller nurseries, a targeted approach based on pests of greatest concern can be effective. Phytosanitation is an essential practice to help prevent the spread of PRAM and other pathogens to or from your nursery operations.

Acknowledgements

Special Thanks to: Gary Chastagner and Marianne Elliott, WA State University; Susan Frankel & Ellen Goheen, USDA Forest Service; Prakash Hebbar & Scott Pfister, USDA, APHIS; Jennifer Parke, OR State University, and Jane Alexander, University of California.

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