

# Recommended Industry Best Management Practices for the Prevention of *Phytophthora ramorum* Introduction in Nursery Operations<sup>1</sup>

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## Abstract

The following industry recommended best management practices (BMPs), designed for growers and/or interstate shippers of host and associated host plants of *Phytophthora ramorum*, consists of biosecurity guidelines created by and for nursery growers in order to reduce the risks associated with *P. ramorum*. The control of *P. ramorum* is based on the insertion of multiple hurdles to prevent the introduction of the pathogen into nursery operations.

The BMPs were created in 2002 when the first United States Department of Agriculture (USDA) *P. ramorum* compliance agreements were issued to interstate shippers from California (CA) quarantined counties. Over the past several years, the draft document has been reviewed and input provided by Agricultural Research Service (ARS) scientists, nursery people, National Plant Board (NPB) members and Horticultural Research Institute members to reflect advancements in research on this pathogen. Collaboration efforts were also undertaken with Canadian and British regulatory agencies.

The BMPs are divided into four management categories: Pest Prevention/Management, Training, Internal/External Audits, Records/Traceability and Documentation. Individual nurseries are encouraged to review these practices and voluntarily apply some or all of them, depending upon their production systems, physical location, nursery type, regional climatic conditions, geographical location and the plants grown. The document is a draft and will continually be updated as research is conducted and made available.

A pilot program to determine the benefit of the BMPs is being developed with the three western state nursery industries and state regulatory agencies operating as third-party auditors.

Key words: *Phytophthora ramorum*, best management practices, prevention, nursery operations.

## Best Management Practices for Nurseries

The following industry recommended best management practices (BMPs), designed for growers and/or interstate shippers of host and associated host plants of *P. ramorum*, consists of biosecurity guidelines created to assist nursery crop producers in developing an effective monitoring and action plan to reduce the risks associated

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with *P. ramorum*. The control of *P. ramorum* is based on minimizing the risk of introduction and preventing the survival of the pathogen within the nursery.

This draft document is designed to offer scientifically-based risk mitigation measures for nurseries. Individual nurseries are encouraged to review these practices and voluntarily apply some or all of them, depending upon their production systems, physical location, nursery type, regional climatic conditions, geographical location and the plants grown.

In the future, it is envisioned that a formal BMP program may be implemented as an alternative to the current federal regulatory approach. Such a program would likely be established as a federal program with collaboration of the United States Department of Agriculture-Animal and Plant Health Inspection Service (USDA-APHIS), the nursery industry, and state departments of agriculture. In a formal program context, each BMP would be accompanied by a documentation sheet identifying the practice that is employed. If a participating grower, in collaboration with the appropriate auditor or oversight authority, determines the BMP is appropriate for the specific nursery, the Site Specific 'Box' would be checked. Additionally, if a BMP is not applicable for a particular site, the N/A 'Box' would be checked. The BMPs which are equivalent to requirements currently mandated in the *P. ramorum* Federal Interim Rule, 7 CFR 301.92, are noted as such in the left margin next to each BMP in this document. Each of the BMPs marked "Regulated" are mandatory.

The 'auditor' or oversight authority would review the documentation sheets on an annual basis. Nurseries will also be responsible for notifying the auditor or oversight authority when a modification to a nursery practice occurs.

The following recommended best management practices for nurseries "free from" *P. ramorum* were developed using the North American Plant Protection Organization's Regional Standard for Phytosanitary Measures (RSPM) Number 24. These risk mitigation measures may be utilized as a stepping stone to a clean stock-like program, such as the United States nursery certification program.

## **I. Pest Prevention/Management**

- A. Moisture Management
- B. Nursery Layout
- C. Cleaning and Sanitation/Plant Debris Handling and Disposal
- D. Weed Control and Established Nursery Plants

## **II. Training**

## **III. Internal/External Monitoring/Audits**

- A. Inspection of Plants

## **IV. Records/Traceability**

- A. Incoming Plants and Returned/Returning Plants
- B. Record Keeping

## **V. Documentation of Program Procedures**

## **VI. High Risk Plants**

## I. Pest Prevention/Management

### A. Moisture Management:

**GOAL:** Minimize moisture conditions conducive to *P. ramorum*.

Regulated  
Specific to Nursery  
NA

BMPs to consider implementing to reach stated goal:

**1) Avoid overhead irrigation of high-risk plants. Irrigate in a manner to avoid prolonged leaf wetness of 12 hours or more.**

Rationale:

Properly time irrigation events to reduce conditions favorable for disease development. Extended leaf wetness (such as overnight) is conducive to pathogen infection.

Requirement for External Audit: documentation of irrigation practices

**2) Irrigation water from any source other than well or municipal water supplies shall be monitored and tested to confirm that it is free from the pathogen.**

Rationale:

For growing operations that utilize open irrigation water sources (ponds, lakes, streams), and/or who blend both well and surface water sources for irrigation purposes, proper water treatment (in other words ozonation, chlorination or other water disinfection program) is recommended. Attention also needs to be directed to possible well water contamination with the *P. ramorum* pathogen by back siphoning of irrigation water or water/soil into the system.

Requirement for External Audit: documentation of water sources

**3) Divert soil and water movement, during storm-related events, from hillsides populated with *P. ramorum* host plants.**

Rationale:

Keep possible offsite contamination from entering production location. Unless the offsite area has been properly surveyed and determined to be *P. ramorum* free, the grower cannot assume that run-off from off-site is not contaminated with *P. ramorum* spores.

Requirement for External Audit: nursery site inspection

- 4) Avoid or minimize accumulation of standing surface water in containerized high-risk (HR) plant beds.**

Rationale:

*Phytophthora* spp. are transmitted via water and repeat finds occur more often in HR plant beds where standing water accumulates. The pathogen may potentially enter through the roots or by splashing onto leaf surfaces.

Requirement for External Audit: documentation of irrigation practices

**B. Nursery Layout:**

**GOAL:** Reduce potential introduction and minimize the spread of *P. ramorum* through nursery operations.

BMPs to consider implementing to reach stated goal:

Regulat

Specific to Nursery

NA

- 1) Reduce potential inoculum splash from high-risk (HR) plants to other crops.**

- a. Create a physical barrier between HR plants and all other crops or
- b. Create a 2-meter break between HR plants and all other crops or
- c. Develop preventive spray program year round when plants have leaves or
- d. Interplant with non-host plants to the genus level.

Rationale:

Many positive plants have been associated with nurseries that have also had positive camellias and/or rhododendrons. (See High Risk proposal)

Requirement for External Audit: nursery site inspection

- 2) Review your Field Layout Plan. Determine how you can minimize the impact of the USDA Confirmed Nursery Protocol if *P. ramorum* is found. Break up long sections of host and associated host plants (HAP) with non-HAP material to the genus level. (USDA-Agricultural Research Service is investigating potential non-host material.)**

Rationale:

Nursery production bed layout, mixing or alternating of HAP and non HAP plant material in production beds can help eliminate large contiguous monocultures of plants that are *P. ramorum* susceptible.

Requirement for External Audit: mapping of stock location

**3) Maintain a separate cull pile for high-risk plants so it is not included in the soil recycling pile for potential future reuse. If infested plants are found, the pile must be quarantined and treated, or disposed of, according to regulatory requirements.**

Rationale:

Proper sanitation measures reduces the risk of spreading the pathogen in the recycled soil within and outside the nursery.

Requirement for External Audit: nursery site inspection

**C. Cleaning and Sanitation/Plant Debris Handling and Disposal:**

**GOAL:** Reduce potential introduction and minimize the spread of *P. ramorum* through nursery practices.

BMPs to consider implementing to reach stated goal:

Regulated  
Specific to Nursery  
NA

**1) For nurseries in high risk (HR) areas (near a native find) or for recurrent nurseries, pick up and dispose of leaf debris in HR plant production areas during the time of year when the pathogen is most prevalent or institute a preventative spray program.**

Rationale:

General sanitation practice. Use of a leaf vacuum is an appropriate method to gather leaves during the time of year when the pathogen is most prevalent, for example early and late winter. Proper disposal of leafy debris should be governed by appropriate local/state/federal recommendations (bagging, burning, burying off site, and so forth).

Requirement for External Audit: nursery site inspection.

**2) After every crop rotation, disinfect propagation mist beds, sorting area, cutting benches, machines and tools to minimize the spread or introduction of pathogens.**

Rationale:

Basic sanitation practices should be followed using registered fungicides in accordance with label instructions to reduce possible points of entry/contamination in the production cycle.

Requirement for External Audit: documentation of nursery personnel training

- 3) If you visit known *P. ramorum* infested areas, wash shoes, tools and vehicles that may have contacted contaminated soils before traveling to disease free areas.**

Rationale:

Best defense is to not visit areas where known infestations are occurring to reduce possible accidental introduction of the pathogen into the nursery production site. If grower has visited infested areas, appropriate sanitation measures (washing and steam cleaning of trucks, and so forth) as recommended by regulatory authorities should be undertaken.

Requirement for External Audit: documentation of nursery sanitation procedures training

- 4) Use new or clean and sanitized pots for high-risk plant production.**

Rationale:

This measure reduces the potential of any unknown residual *P. ramorum* contamination on the nursery site and possible further disseminating of the pathogen throughout the nursery. New pots should be stored and handled in such a manner as to avoid contact with potential *P. ramorum* sources. Recycled pots should be thoroughly cleaned of any residual substrate and disinfected before reuse. Recycled pots should also be stored and handled in such a manner as to avoid contact with potential *P. ramorum* sources.

Requirement for External Audit: documentation of nursery sanitation practices

- 5) Ensure runoff from all cull piles is directed away from soil components, soil mixing area, and growing beds to prevent contamination.**

Rationale:

Avoids any possibility of cross contamination. If growers cull infested material, sanitation methods should be established to clean/disinfect trucks, wagons, and tools that are used to move infested material.

Requirement for External Audit: nursery site inspection

- 6) For plants that are prone to disease, chemically treat crop in field prior to taking cuttings and dip cuttings in an approved disinfectant solution before sticking.**

Rationale:

Treatment of stock plants with registered disinfectant(s) before cutting of the propagation material can reduce the

possible introduction of contaminated plant material into the propagation cycle and protect the open wounds from possible pathogen infection.

Requirement for External Audit: nursery pesticide

**D. Weed Control and Established Nursery Plants:**

**GOAL:** Reduce the potential for inoculum buildup of *P. ramorum* in weeds and established nursery plants.

BMPs to consider implementing to reach stated goal:

Regulated  
 Specific to Nursery  
 NA

**1) Manage weeds on the nursery site as they can potentially serve as alternate hosts of *P. ramorum*.**

Rationale:  
 Maintaining clean cultivation in and around the production site may eliminate possible reservoirs of *P. ramorum* pathogen. Since it is not known if insect vectors can also carry *P. ramorum*, clean cultivation will reduce opportunities for insect infestations and contamination in the nursery.

Requirement for External Audit: nursery site inspection

**2) No over story or under story of known *P. ramorum* hosts on nursery growing grounds should be maintained unless regular monitoring of those hosts is performed.**

Rationale:  
 Reduce the potential of offsite contamination of *P. ramorum* into the production site by establishing a regular monitoring program for *P. ramorum* host plants in the environs of the nursery. Monitoring program should be based upon the specific life cycle of the disease within that specific growing region and the time of year when the pathogen is most prevalent.

Requirement for External Audit: nursery site inspection

**II. Training**

Regulated  
 Specific to Nursery  
 NA

**GOAL:** Enhance prompt disease recognition.

BMPs to consider implementing to reach stated goal:

**1) Nursery personnel should attend one or more *P. ramorum* trainings conducted by qualified personnel or document self-training via one of the two websites below**

Rationale:

Responsibility for *P. ramorum* management on nursery site should be the responsibility of a specified group of trained nursery personnel. These individuals should be trained in all aspects of the management of the disease. Special attention should be given to staying informed of new research findings regarding the disease and any changes in regulations regarding plant sampling, testing or shipping of product. Training is available through the USDA-Forest Service, CA Oak Mortality Task Force (COMTF), state agriculture departments, county agricultural commissioners offices or through selected universities.

On line at USDA website:

[www.aphis.usda.gov/ppq/ispm/pramorom](http://www.aphis.usda.gov/ppq/ispm/pramorom)

Or on line at COMTF website: [www.suddenoakdeath.org](http://www.suddenoakdeath.org)

Requirement for External Audit: documentation of training



**2) Educate nursery personnel to recognize and report pest or disease problems.**

Rationale:

Personnel should be trained to not only look for *P. ramorum* symptoms but for any symptoms of plant abnormality in the production system.

Requirement for External Audit: documentation of training



**3) Educate employees and managers about their company's implemented BMP's.**

Rationale:

Appropriate manager(s) should work with their state agriculture department, county agriculture department and/or knowledgeable university personnel to identify the specific, appropriate recommended BMPs to implement in order to minimize the risk of introduction of *P. ramorum* into their nursery operation.

Requirement for External Audit: documentation of training

### III. Internal and External Monitoring/Audits

**GOAL:** Regularly inspect plants in and around the nursery to ensure earliest possible detection of *P. ramorum* infection.

Regulated  
Specific to Nursery  
NA

BMPs to consider implementing to reach stated goal:

**1) Annual nursery inspection of all plants in the nursery with a focus on *P. ramorum*-like symptoms. Inspection includes mandatory testing of at least 40 symptomatic samples.**

Rationale:

The host list continues to expand and as a result, all plants need to be inspected for *P. ramorum*-like symptoms. Current state and federal regulations require a minimum of 40 samples to be taken and tested.

Requirement for External Audit: annual nursery inspection report

**2) Nursery to inspect high-risk (HR) plants, such as camellias and rhododendrons, monthly throughout the growing season, particularly after pruning or a significant weather event.**

**Regulators to inspect HR plants twice a year. Train employees to look for and report symptoms when working with the HR plants.**

Rationale:

*Camellia* and *Rhododendron* species have comprised the majority of the total positive plants in nursery settings throughout the regulated area. (See High Risk Proposal-under discussion if to whether or not this BMP should be regulated)

Requirement for External Audit: documentation of nursery practices

**3) Routinely monitor incoming HAP for symptoms of *P. ramorum*.**

Rationale:

First line of defense. Grower priority should be to ensure that potentially contaminated stock is not allowed to enter the production site.

Requirement for External Audit: documentation of nursery practices

**4) Routinely\* inspect HAP in the landscape on the growing grounds and in the surrounding area for symptoms of *P. ramorum*.**

Rationale:

HAP plant material should be visually screened on a regular basis for any abnormalities. \*Special attention should be given to those times when the pathogen is most prevalent.

Requirement for External Audit: documentation of nursery practices

**5) Ensure the use of *P. ramorum* free growing media/growth substrate.**

Rationale:

Given that *P. ramorum* may contaminate potting substrates, it is critical for the grower to reduce any sources of contamination in peat, bark, and other organic components of the substrate. Proper documentation of disease free substrate materials shipped into the site should be obtained. Proper storage and prompt use of substrate materials (for example covered, prevented from contact with native soil), is critical.

Requirement for External Audit: documentation of nursery practices

**IV. Records/Traceability**

**A. Incoming Plants and Returned/Returning Plants:**

Regulated
Specific to Nursery
NA

**GOAL:** Reduce the potential introduction and spread of *P. ramorum* through nursery trade.

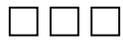
BMPs to consider implementing to reach stated goal:

**1) Confirm nursery stock is propagated from materials obtained onsite, or is received from nurseries that are licensed and/or certified according to all applicable phytosanitary laws and regulations.**

Rationale:

First line of defense. Know your supplier. Grower priority should be to ensure that potentially contaminated stock is not purchased or allowed to enter production site.

Requirement for External Audit: documentation of nursery practices

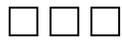


**2) Avoid product returns of nursery stock from a receiver in a quarantined area or from nurseries that are not under *P. ramorum* compliance. If unavoidable, contact your county agriculture department or appropriate plant regulatory agency prior to accepting the nursery stock return.**

Rationale:

Avoids possible cross contamination. Returned stock may have been exposed to *P. ramorum* prior to return.

Requirement for External Audit: nursery map, documentation of nursery practices.

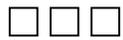


**3) Nurseries should avoid commingling incoming HAP nursery stock with existing stock.**

Rationale:

Avoids cross contamination of clean and potentially diseased material. Assists with inventory control and tracking of plant material in the nursery.

Requirement for External Audit: documentation of nursery practices, nursery site inspection

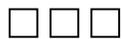


**4) For HAP buy-ins, suspend the use of *Phytophthora* specific fungicides on 10 percent or 100 plants, whichever is fewer, for a two month period to determine if fungicides that may have been used by seller were masking symptoms of *P. ramorum* or, through your state agricultural department, sample and test a representative group via ELISA or PCR. If tests are negative, the above BMP is not applicable.**

Rationale:

This recommendation correlates with a3 (above) and supplements isolation efforts.

Requirement for External Audit: documentation of nursery practices



**5) Authorized and knowledgeable personnel should visually inspect all nursery stock (buy-ins, transfers, and returns), regardless of origin, for symptoms of *P. ramorum* prior to introduction into the nursery facility.**

Rationale:

Because not all areas of the country can be certified *P. ramorum* free, this visual evaluation of off-site nursery stock can provide a major screening defense to the introduction of the pathogen.

Requirement for External Audit: documentation of nursery personnel training, documentation of nursery practices

- 6) Off load incoming HR plant shipments to an area that can be cleaned of leafy debris. Sweep incoming plant debris from the receiving area and the delivery truck. Collect debris and dispose of appropriately.**

Rationale:

Basic sanitation to remove possible sources of disease inoculum. Proper disposal of leafy debris should be governed by appropriate local/state/federal recommendations (bagging, burning, burying off site, and so forth). Composting of infected plant debris is not an acceptable practice. Leaf litter has been shown to be a potential source of inoculum.

Requirement for External Audit: documentation of nursery

- 7) Monitor sanitation practices of delivery trucks that ship HR plants. Assure that trucks are properly cleaned of plant debris between shipments.**

Rationale:

Trucks may be a source of inoculum if not cleaned properly.

Requirement for External Audit: documentation of nursery practices

**B. Record Keeping:**

**GOAL:** Keep incoming and outgoing plant records for the purpose of identifying where plants originated and where plants have been sent in the event the nursery is found infested with *P. ramorum*.

BMPs to consider implementing to reach stated goal:

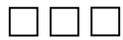
Regulated  
 Specific to Nursery  
 N/A

- 1) Maintain for two years minimum: accurate shipping documentation identifying product, amount, date and origin or receiver for the purpose of identifying trace backs and trace forwards.**

Rationale:

Proper documentation protects not only the grower but also the receiver of plant material. Production operation should investigate methods for quick recording and retrieval of documentation. Disease monitoring and scouting results should be integrated with inventory control to provide rapid trace forward and back of suspected infested nursery stock.

Requirement for External Audit: nursery inspection (of records).



**2) Consider strategies that would facilitate the rapid identification and segregation of product based upon production location from the time it has left the growing operation through final sale.**

Rationale:

Operations personnel should develop a “Code Red” crisis management plan for dealing with possible *P. ramorum* infestations that stresses containment and considers all aspects of the plant production cycle, but especially the movement of plant material around site and shipping off site.

Requirement for External Audit: written nursery “Code Red” plan

## V. Documentation of Program Procedures

**GOAL:** Provide proof that the nursery’s BMP’s are documents and implemented.

Example information to include in manual:

- 1) Employee training records
- 2) Internal systems review procedure
- 3) List of implemented BMPs that are appropriate for your site based upon the nurseries specific production systems, physical location, nursery type, regional climatic conditions and the plants grown. Documentation sheets are being developed for each BMP

## VI. High risk plants

The NPB Western region high risk proposal is aimed at camellias and rhododendrons with the caveat that should any other plant demonstrate the same level of risk, they be added to the mitigation measures the Working Group agrees to. In the western region, 88 percent of infected plants are in either of these two genera.

- 1) In CA: *Camellia* and *Rhododendron*
- 2) In BC, OR, WA: *Camellia*, *Rhododendron*

This document is a work in progress. Please use the following contact information for all questions, comments or suggestions:

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