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BIOSECURITY SCHEME

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Phytophthora

Specific Module

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Phytophthora Specific Module

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Updates

The Plant Production Biosecurity Scheme (PPBS) is a science-based framework to help producers identify, control, manage and avoid biosecurity risk. The scheme and standards are based on work undertaken early in 2018 in following experience early in the myrtle rust response that underscored the crucial role that plant producers play in early detection of pests, their containment and slowing their spread following a pest incursion. Subsequent discussions identified the opportunity to develop a systematic approach to plant production industry biosecurity risk management.

Revisions will be ongoing as PPBS experience and/or new science inform the need for change. Revisions published on the Scheme's website [to follow] and participants advised of the changes and new documents, so they can ensure that they are referring to the most recent documents.

Those wishing to provide recommendations for change should send these in writing to PPBS or by email to [in the interim office@nzppi.co.nz].

Acknowledgements

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Disclaimer

While this standard's objective is to allow certification of plant producers and confidence that the plants they produce have been grown under conditions of high biosecurity risk and hazard management, there remains the possibility a proportion of plants may contain biosecurity pests. PPBS accepts no liability for claims regarding the presence of pests in any plants produced by registered and/or certified producers. While the objective of this standard and guidelines is to minimise the potential risk pest, no party can guarantee that adherence to these standards and guidelines will reduce such risk to zero.

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Phytophthora

Specific Module

measures to manage Phytophthora in addition to the core standard and checklist

Phytophthora Specific Module

1. Purpose

This document is a Specific Module that outlines measures for plant producers where *Phytophthora* is a concern to their plant stock and/or distribution pathways. It supplements the Core Standard of the Plant Production Biosecurity Scheme (PPBS, the Scheme), and describes specific measures to manage the risk of a nursery becoming infested by or spreading *Phytophthora*.

2. Introduction

Phytophthora is a genus of plant-damaging water mould (oomycete) pathogens, whose member species can cause enormous environmental damage in natural ecosystems as well as economic losses on crops. Some 170 species have been described, though it is considered many more are undiscovered.

Phytophthora species have been isolated as the causal agents for root and stem rot diseases in a broad range of arable and horticultural crops, and forest, amenity and ornamental plants. *P. agathidicida* for example is the primary agent responsible for kauri dieback. Others include *P. ramorum* (sudden oak death) which has killed millions of trees in California, and *P. cinnamomi*, which is known as Jarrah dieback in the south-west of Western Australia where it affects more than 40 per cent of native plant species and half of those endangered. *Phytophthora* species also cause foliar diseases and sometimes the same pathogen causes foliar, stem, and root disease depending on the host it is infecting.

Water and soil-borne *Phytophthora* species infect fine roots and the bark of the collar region with highly mobile biflagellate zoospores released from sporangia during wet soil conditions. Airborne *Phytophthora* species infect leaves, shoots, fruits, bark of branches and stems with caducous sporangia produced during humid conditions on infected plant tissues and spore dispersed by wind and rain splash.

Phytophthora oospores are usually formed in diseased plant tissue, both on infected plants and in pieces of decaying tissue on the ground. They can also be found in soil after decay of infected plant tissue. They are highly persistent and can remain viable in a dormant state for several years. Oospores are difficult to destroy and under the right conditions germinate and develop mycelia or produce sporangia which go on to impact plant health.

Phytophthora species present a significant threat to plants in agriculture, horticulture, forestry, natural and built ecosystems as they:

- Can be easily dispersed through soil, water or aerial borne reproductive structures, or through many human activities.
- Often have a wide host range infecting exotic and indigenous plant systems, affecting many different species through the deterioration of ecosystems.
- Are increasingly being spread internationally through globalisation and plant trade, giving rise to the opportunity for new pathogen/host relationships.
- Can form new hybrid species within managed and natural ecosystems, which may lead to rapid generation of new pathogens and diseases.
- Are difficult to identify in asymptomatic host tissues or where symptoms have been suppressed with phosphite as is widely the case with nursery stock.

Phytophthora pathogens are common in many nurseries and nursery conditions provide an ideal environment for the development of the pathogen. *Phytophthora* can stunt or kill plants in the nursery, although infected plants may

remain not show symptoms for a long time after infection. Infected plants (symptomatic or not) spread *Phytophthora* to natural ecosystems, gardens and urban landscapes, forests and to food producers.

Management of *Phytophthora* in nurseries focuses on preventing their introduction and establishment; elimination once established is difficult. A clean production emphasis and a systems-based approach to nursery hygiene have been found effective in ensuring nurseries and their plants remain *Phytophthora*-free; the goal to prevent the introduction of *Phytophthora* into the nursery. If there is no *Phytophthora*, there will be no *Phytophthora* diseases (Swiecki and Bernhardt 2016).

Recently a suite of *Phytophthora* prevention measures have been found to be effective in reducing *Phytophthora* incidence in and riding facilities of *Phytophthora* where a rigorous programme of water and soil management, staff training, and sanitation was implemented (Sims et al 2019). That programme is analogous to the measures in the PPBS Core Standard and this module.

3. Scope

This *Phytophthora* Specific Module is designed to:

1. Support the PPBS Core Standard

Measures in the Core Standard and the PPBS Guidance materials manage generic *Phytophthora* risk that is faced by most nurseries, plants species and plant distribution pathways and markets.

Core Standard requirements are considered adequate to manage *Phytophthora* risk at a general level, and this Module does not specify further mandatory Standard requirements.

However, where *Phytophthora* is of heightened concern to the plant producer, their customers, plant distribution or end use, this module provides additional guidance is provided and should be read in association with that standard. It identifies key risk issues and provides cross reference to the Core Standard's requirements and guidance.

2. Act as an umbrella for Specific Management Schedules for *Phytophthora* species of concern.

Some *Phytophthora* species present a major threat to New Zealand's agriculture, horticulture, forestry, natural and built ecosystems; example *P. agathidicida* (kauri dieback). Additional Standard measures (a Specific Schedule) are required (mandatory) to ensure a nursery and its plants are free of the *Phytophthora* species of concern and that Certification can be extended to this risk issue.

Specific Schedules may require additional management and cultural practices, monitoring, reporting, diagnostics, and treatments. They will likely specify pathogen freedom in nurseries evidenced by monitoring and diagnostics. Certification to a *Phytophthora* Specific Management Schedule relies upon and can only be granted by the PPBS where a plant producer meets the requirements for certification to the Core Standard.

4. Managing Nursery Risk

Managing *Phytophthora* in a nursery is confounded by several issues:

- **Nursery conditions are favourable for *Phytophthora***

Plant nurseries provide nearly optimal environments for the development and spread of *Phytophthora* diseases. Production and dispersal of *Phytophthora* sporangia and swimming zoospores are favoured by the wet and humid conditions found in nurseries. High root density within containers, close spacing of plants, plant handling, and frequent rearranging of containers all enhance opportunities for pathogen spread and reproduction.

- **Diseased plants are difficult to detect**

Foliar and aerial signs and symptoms caused by *Phytophthora* may be confused with symptoms of other

nursery diseases, insufficient water or fertilizer burn. Root rot symptoms can be even harder to detect. Many plants will not show obvious above-ground symptoms under nursery conditions until root rot is severe.

- **Some fungicides suppress but do not eliminate *Phytophthora***

Phenylamide and phosphonate fungicides do not kill *Phytophthora*; they can only prevent or reduce establishment of the *Phytophthora* before it colonises the plant. They can also prevent or reduce continued growth if the organism is already inside the plant. The result is that they can delay symptoms and the plant can appear asymptomatic, but once chemical activity has subsided over time, the *Phytophthora* can resume growth within infected plants.

- **Symptoms vary from host to host**

Phytophthora signs and symptoms can vary between host species. For example, sudden oak death on tree species is characterized by 'bleeding' cankers that girdle the trunk of tanoaks and some other oak species. On rhododendron, pieris, viburnum and camellia, the disease is characterized by leaf blights and shoot diebacks.

- **Infected plants can be asymptomatic**

At earlier disease stages or from the application of fungicides, plants can be infected but foliage and roots can still appear healthy. Infected, but asymptomatic plants can then be readily distributed to customers, as was the case in the 2004 sudden oak death spread from California and Oregon nurseries. Additionally, productivity among infected but asymptomatic nursery crops is diminished as a result of impaired root activity.

- **Eradication of *Phytophthora* from infected plants and nursery sites**

Currently there are no methods available to eradicate *Phytophthora* from infected plants. *Phytophthora* can be eradicated from containerised systems by sterilising soil and containers. For inground nurseries, fumigation of soil can remove *Phytophthora* but can be reinfested by *Phytophthora* propagules moving in ground water from other areas; fumigation also removes other beneficial microbes from soil.

Prevention rather than cure

Owing to the issues above nursery best practice has increasingly focused on an integrated approach to prevent *Phytophthora* (and other pathogens) from entering nurseries and their subsequent spread through the production cycle through to out planting. It is necessary to adopt an entire clean production system to achieve the goal of producing healthy plants, this includes a high standard of nursery hygiene: clean stock, clean soil, clean water.

Clean Plant Production

The concept behind a clean production system can be summarized in two points:

- **Start clean** by use of clean starting components, including plant propagules, containers, potting media, and water ...
- **Stay clean** by using clean production practices and organizing nurseries in a way that separates potentially contaminated materials from clean plants ...

Increasingly a systems approach has been adopted as a means of excluding and improving control of pathogens in nursery production systems and preventing their distribution with nursery stock. Hazards are analysed and measures and controls implemented at the earliest point of risk. The approach facilitates improvement by continued learning and assessment of outcomes enabling implementation of new and revised control strategies.

Nursery Risk Pathway and Mitigations

Key opportunities for *Phytophthora* to enter a nursery and spread through its production cycle include:

- Contaminated propagules or imported infected (but possibly asymptomatic) plant materials and any associated substrates (soil and or potting media for example).
- Contaminated water, potting and growing media or pots.
- Poor sanitation practices and use of contaminated equipment through the production cycle.

The PPBS Core Standard focuses strongly on nursery hygiene and other measures that help keep a nursery, its production facilities and stock free of *Phytophthora*. They include generic management and cultural practices designed to:

- Reduce the risk of nurseries becoming infested with a broad range of *Phytophthora* species.
- Ensure that it is detected early should an infection occur.
- Reduce the likelihood of *Phytophthora* species being spread through the nursery.
- Reduce the likelihood of *Phytophthora* species being spread through the nursery stock distribution pathway.

5. Nursery measures

The following tabulation identifies key risk issues and provides cross reference to the Core Standard’s requirements and mitigations described in PPBS Guidance materials.

In addition, where *Phytophthora* is of heightened concern to the plant producer, their customers or stock distribution pathway or end use, additional guidance is provided.

5.1. Workers		
Ensure that all personnel that work in the nursery consistently follow phytosanitary practices.		
Core Standard & Guidance	6.3 7.2	Worker training Hygiene – nursery personnel
Additional guidance	<ul style="list-style-type: none"> • Ensure awareness and training processes include <i>Phytophthora</i> issues, susceptible host plants, what to look for and how to respond if signs or symptoms are suspected. 	
5.2. Visitors		
Ensure that all personnel that visit the nursery are aware of and undertake phytosanitary risk measures.		
Core Standard & Guidance	6.4 6.5 7.2	Signage Visitors Hygiene - nursery access, equipment cleaning (vehicles)
5.3. Design, layout and workflow		
Use the design and layout of the nursery to reduce opportunities for introducing contamination into or among plant stock.		
Core Standard & Guidance	7.2 8.2.1 9.2.1 10.2.1	Hygiene – plant and waste materials, nursery site and work and growing areas Growing areas – all types Growing areas – container production Growing areas – bare root and field production
Additional guidance	<ul style="list-style-type: none"> • If possible, breakup long blocks of host plants to provide buffer to limit spread from crop to crop. • Isolate potential contamination sources (trash bins, dirty pots ...). • Consider post-pruning fungicide to protect wounds. 	
5.4. Tools, surfaces and environment		
Use thought and care in all aspects of plant handling to prevent contamination in various plant production and maintenance activities.		

Core Standard & Guidance	7.2 8.2.1 9.2.1 10.2.1	Hygiene – equipment cleaning and work and growing areas Growing areas – all types Growing areas – container production Growing areas – bare root and field production
Additional guidance		<ul style="list-style-type: none"> Regularly clean and sanitise all working areas and equipment linked to potting and preparation of potting media.
5.5. Crop protection and monitoring		
Identify potentially diseased material at the earliest possible stage so it can be culled in a timely manner to prevent further spread in the nursery.		
Core Standard & Guidance	7.3 8.2.3	Crop monitoring Crop protection
Additional guidance		<ul style="list-style-type: none"> Avoid application of fungicides for the control of <i>Phytophthora</i> (eg phosphites). These can delay onset of symptoms in plants that are already infected. Remove suspect plants to isolation area immediately, identify original location and monitor nearby plants for symptoms.
5.6. Plant materials		
Start with propagative material that is free from infection or external contamination by <i>Phytophthora</i> species as well as other possible pathogens.		
Core Standard & Guidance	8.1.1 8.1.5	Plant stock for propagation &/or planting Propagation
Additional guidance		<p>Bought in plants</p> <ul style="list-style-type: none"> Bought-in plants are a major risk pathway for <i>Phytophthora</i> species between nurseries. <ul style="list-style-type: none"> Avoid using bought-in plants where possible. If bought-in plants are needed: <ul style="list-style-type: none"> Source micro-propagated plants preferentially. Accept plant material (including soil and/or potting mix) sourced only from reputable suppliers who can demonstrate they have systems in place to avoid contamination of the material they supply. Do not treat plant material with fungicides on arrival, so if the material has asymptomatic infection, it allows time for the pathogen to grow and the disease symptoms to be observed. Isolate bought-in plants from other stock for as long as practicable. This too allows time for the pathogen to grow and the disease symptoms to be observed before other stock is placed at risk of infection. <p>Processing field collected seed and propagules</p> <ul style="list-style-type: none"> Where compatible with seed, treat to eliminate potential pathogens. Segregate soil-sourced propagules from seed/cuttings. <p>Stock plants</p> <ul style="list-style-type: none"> Consider pathogen testing mother stock plants prior to the “propagation” season. Grow stock plants in containers in clean areas with generous spacing. Irrigate stock plants by trickle. Do not treat stock plants with fungicides.

5.7. Growing media

All potting media must be pathogen free and be handled and stored in a manner that precludes contamination.

Core Standard & Guidance	8.1.2	Growing media
Additional guidance	<ul style="list-style-type: none"> Consider pasteurisation before use with high risk crops in sensitive production areas – example, propagation. 	

5.8. Containers

Use only clean pots, trays, bags or other types of containers to eliminate these as a potential source of pathogens

Core Standard & Guidance	8.1.4	Containers (pots, bags, trays ...).
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5.9. Irrigation

Use only uncontaminated, appropriately treated water for irrigation.

Core Standard & Guidance	9.2.2	Irrigation – container production
Additional guidance	<ul style="list-style-type: none"> In preference and where practicable, avoid overhead irrigation. <ul style="list-style-type: none"> If irrigating overhead, schedule for times where leaf surfaces will dry quickly Use low water pressure to avoid splash. 	

5.10. Container growing area management

Provide enough space between plants and potential sources of contamination to minimize the risk of contamination via water splash.

Core Standard & Guidance	8.2.1 9.2.1	Growing areas – all types Growing areas – container production
Additional guidance	<ul style="list-style-type: none"> Ideally grow plants on benches at least 90cm off ground. Avoid wooden bench tops. Space benches, beds and crops to minimise risk of crop to crop splash. Space plants to minimise risk of pot to pot splash. Avoid unnecessary movement or rearranging of plants on the growing bed. If a disease is developing, it is important to be able to notice patterns as they might develop across a crop. Discard plants that have been in contact with ground or un-sanitised surfaces. Avoid dust and splash when cleaning. 	

5.11. Bare root and field growing area management

In-ground production of *Phytophthora* prone species is particularly problematic – soil and water are natural *Phytophthora* habitats.

Core Standard & Guidance	8.2.1 10.2.1	Growing areas – all types Growing areas – bare root and field production
Additional guidance	<ul style="list-style-type: none"> Avoid in-ground nursery production wherever possible. Plants grown in-ground cannot be considered free of <i>Phytophthora</i>. 	

	<ul style="list-style-type: none"> Mulch field-growing plants to minimise risk of water splash and <i>Phytophthora</i> being spread from soil to foliage.
5.12. Plant Distribution	
Follow phytosanitary procedures to maintain clean stock until it has been transferred to the customer.	
Core Standard & Guidance	8.4 Plant distribution and transport

Appendices

6. References

- Swiecki and Bernhardt 2016 - Ted Swiecki and Elizabeth Bernhardt, Phytosphere Research. CNPS Best Management Practices (BMPs) for Producing Clean Nursery Stock
<https://docs.google.com/viewer?a=v&pid=sites&srcid=ZGVmYXVsdGRvbWFpbnxjbjBzY2hhcHRlcmNvdW5jaWxtYXJjaDIwMTZ8Z3g6NDU0NGY3OWQ3MWFINTgzMg>
- Sims et al 2019 - Laura Sims, Steven Tjosvol, David Chambers & Matteo Garbelotto. Phytophthora species in plant stock for habitat restoration can be controlled through best management practices. *Plant Pathology*. 68, 196-204, 2019
<https://www.researchgate.net/publication/327165019>