23/01/2024

Managing Phytophthora in Macadamias

MARQUIS



Key Points

- *Phytophthora* decline can be a symptom of poor soil health and orchard floor conditions.
- Applying mulches, rich in organic matter to improve soil health and favour root growth, will significantly reduce the effect of *Phytophthora* in orchards.
- Phosphorous acid applications, after spring and autumn leaf flush maturity, will help rejuvenate affected trees.
- Purchasing quality nursery trees, free from *Phytophthora*, is critical to limiting disease impacts.
- Severely affected trees will take at least two years to recover.
- Prolonged wet-weather favours *Phytophthora* infection but symptoms are more apparent in dry periods.



In 2017, *Phytophthora* diseases were estimated to cost the Australian macadamia industry at least \$20 million annually in lost production and management costs. Cool, wet soil conditions favour growth and infection of *Phytophthora*, causing root rot, trunk cankers and tree decline. Water stress and tree decline symptoms are usually seen during prolonged dry weather as affected trees do not have adequate root systems to take up water.

MARQUIS

Phytophthora is found in all macadamia producing areas. Macadamia trees are considered *Phytophthora* tolerant. *Phytophthora* decline in orchards is a symptom of poor soil health and orchard floor conditions. Creating an orchard soil environment that favours root growth by, managing waterflows to reduce erosion, improving subsurface drainage in wet areas, mulching to cover roots, reducing root damage and improving soil health, will significantly reduce *Phytophthora* effects in orchards.

What is Phytophthora?

Phytophthora species are water moulds that thrive in cool, damp soil conditions. *Phytophthora cinnamomi* is the most common species affecting macadamia; however, more than one *Phytophthora* species may attack macadamias.

Despite growing similarly to fungi, *Phytophthora* are related to seaweeds and have cellulose in their cell walls, not chitin like fungi. Enzymes produced by soil organisms that break down the cellulose in organic matter and mulches also attack *Phytophthora*. This helps explain why adding mulches improves *Phytophthora* management and reduces *Phytophthora* soil populations.

Contrary to popular belief *Phytophthora* does not like continually waterlogged soils. *Phytophthora* requires saturated soil pores for spore dispersal but, like roots, requires oxygen to survive. Tree decline in orchard areas with extended periods of waterlogging suffer from root drowning. Trees should not be planted in areas subject to extended waterlogging unless subsurface drainage has been installed to alleviate the waterlogging.



Figure 1. A sparse, yellow canopy (L), trunk canker (M) and suckering (R) can be signs of *Phytophthora* infection.



What does Phytophthora do to macadamia trees?

Phytophthora damages the roots and trunk of macadamia trees. Other signs of the disease include trunk cankers, sap bleeding, suckering and root rot (Figure 1). Cankers can progress from the trunk into the limbs. This damage weakens or kills the tree. Root damage exacerbates moisture stress at all crop stages.

Phytophthora symptoms are most visible during dry weather periods or when trees are otherwise stressed. Leaves on trees of all ages, infected with Phytophthora, become yellow and may prematurely drop (Figure 1). Excessive leaf drop from *Phytophthora* infection results in a sparse canopy and gradual tree decline.

With adequate soil moisture levels, *Phytophthora* symptoms are rarely seen as healthy roots can provide enough resources for the tree requirements. If soil moisture levels drop or when trees start to actively grow, flower, or produce nuts, the damaged root system struggles to meet tree moisture and nutrient requirements. Infected trees flower poorly, drop nut prematurely and have reduced tree vigour.

How does Phytophthora spread in orchards?

Phytophthora produces several different spore types (Figure 2). Spores can survive a few weeks to years, depending on the spore type. Infection occurs through trunk wounds, damaged surface roots or directly through healthy roots.

When *Phytophthora* infects a host, it grows by producing microscopic filaments called mycelium. The mycelium can spread from one macadamia tree to the next through intertwined roots. Spores spread through the orchard via infested water or soil and are attracted to, and swim towards, carbohydrates and amino acids exuded from the roots.



Figure 2. Lifecycle of *Phytophthora* species. Modified from Cooke et. al 2009.



Managing Phytophthora

An integrated approach is the best way to manage *Phytophthora*. This should focus on addressing soil and orchard floor constraints by:

- managing waterflows onto, and within orchards, to improve drainage and reduce erosion
- improving soil health
- covering exposed roots by reprofiling, applying mulch, manure and compost
- reducing root and trunk damage during orchard operations.

The 'snap' test is a simple diagnostic tool to assess macadamia root health.

- 1. Clear a small section of grass or mulch from the soil surface under the tree canopy.
- 2. Push a small fork, at a slight angle, into the top few centimetres of soil.
- 3. Push the handle downwards.

The sound of multiple roots snapping indicates a healthy root system. No snapping sound and few visible fine feeder roots indicates a poor root system.

Orchard Design

New orchard design should consider the following:

- areas that become waterlogged should not be planted
- surface water flows should be diverted away from the orchard
- · ensure good drainage when designing new orchards
- marginal areas should be mounded or sub-surfaced drained to avoid the risk of waterlogging.

Don't assume that if the orchard is on a slope that drainage is adequate as springs and soaks can be present on slopes, especially during wetter periods, and provide conditions for disease development.

Cultural Practices

Exclusion and sanitation

Prevention or exclusion is the best management strategy for all pest and diseases. Few established macadamia orchard sites are free from *Phytophthora*. New trees should be purchased from nurseries produced under the following conditions.

Potting mixes should be:

- free from soil as soil can introduce disease like Phytophthora to potting mixes
- pasteurised or composted to ensure they are pathogen free
- produced and stored off the soil to avoid contamination
- water from dams or tanks used in nurseries should be treated, unless used directly from a bore or town water
- planted pots or bags should be on a free draining surface or on benches.



Figure 3. Key components of managing *Phytophthora* in macadamia orchards. Modified from the 'Pegg Wheel' used by the Australian avocado industry.

Irrigation management

Irrigation systems should be designed to avoid overwatering. Monitoring tools should be used to schedule irrigation and pressure compensated sprinklers can help ensure even applications. Irrigation lines should be stepped down to smaller pipe diameters towards the base of slopes to reduce the amount of residual water in lines at the end of irrigation cycles and the potential for overwatering. Blocks that have similar water requirements and water infiltration rates should be watered together.

Infected trees use less water than healthy trees and over-watering can create temporary waterlogging, favouring further *Phytophthora* infection. If trees show signs of *Phytophthora*, changing sprinklers on these trees to a lower flow rate reduces the risk of overwatering.

Organic amendments and mulching

Phytophthora appears to be suppressed in rainforests by healthy soils with high levels of organic material and high microbial activity. Growers can replicate this in macadamia orchards by mulching. Organic matter breaks down slowly and nutrients are released over time in a plant-available form. The residual organic matter stimulates competitive and antagonistic micro-organisms in the soil. Reprofiling interrows or using organic matter to cover roots reduces damage during harvest and the potential for *Phytophthora* infection.

As well as helping manage *Phytophthora*, organic amendments applied to macadamia orchards:

MARQUIS

- improve soil structure
- promote root development in an oxygen rich environment
- increase nutrient uptake and recycling
- decrease evaporation and maintain soil moisture levels during drought conditions
- increase soil water holding capacity reducing wet and dry extremes that induce stress
- improve drainage and infiltration
- regulate soil temperature
- provide nutrients for soil microbes increasing microbial activity.



Figure 4. Applying mulch to a macadamia orchard

Chemical treatments

Agricultural chemicals are a short-term solution to help return trees to health, until soil constraints are addressed. In autumn and spring, after leaf flushes have matured, trees produce new roots. This is the most effective time to use chemical treatments to protect the roots and help manage *Phytophthora*.

Two chemicals are registered to help manage *Phytophthora*. These are best used as part of a long-term protection and prevention strategies that include mulching to improve soil health and ensuring good orchard drainage. Always apply chemicals as directed by the label and follow all safety precautions. Check the APVMA website to confirm the product has a current label registration or permit (https://apvma.gov.au/node/10831).

Table 1. Plant health based management options for *Phytophthora* in macadamia.

	Plant description		Management strategy	
Disease severity	Root abundance	Canopy health	Cultural	Chemical
none	high	healthy, dark green	continue current practices	none
low	moderate	low leaf density, little or no flush	improve cultural practices	apply to protect new root flush
moderate	low	sparse canopy, dead branches	apply large amounts of organic matter	apply to protect new root flush
high	sparse	dead (sticky) tops	apply large amounts of organic matter	apply to protect new root flush

Phosphorous acid

Phosphorous acid, commonly called phos acid, is registered to manage *Phytophthora* in macadamias. Phos acid moves internally, up and down the plant, and accumulates in the plant part most actively growing at the time of application. Phos acid response is less effective in trees weakened by environmental stress as it reduces the movement within the tree. Phos acid does not reduce *Phytophthora* populations in the soil but stimulates the plant's natural defence responses and allows root development without loss to *Phytophthora*.

To effectively manage *Phytophthora*, phos acid must accumulate in the roots. Macadamia roots flush at different times to leaves. When leaves are flushing, the bulk of the tree's nutrients are moving to the leaves. If phos acid is applied when leaves are flushing it will accumulate in the leaves. When the flush has matured or hardened (Figures 5 and 6), carbohydrates and other products move down the tree promoting a root flush. Apply phos acid when the leaf flush is mature to ensure it accumulates in the roots.

Phos acid is registered as either a foliar spray or a trunk drench not as a soil drench application like metalaxyl. Do not apply to trees under severe stress or during hot weather. Trees need to be fully hydrated for good phos acid uptake. Phos acid has a withholding period of 14 days.



Foliar applications

Apply phos acid to the foliage after the spring and autumn leaf flush has hardened. Ensure complete coverage of the foliage. Do not apply phos acid within two weeks of copper sprays to avoid leaf burn. Apply at high volume, 2000-3000 L/ha and maximum of two applications per crop. Spray at a rate of 170-200 ml/100 L of the 600 g/L product.



Figure 5. Mature flush at the correct stage for Phos acid applications (L), immature flush too early for phos acid applications (R).

Trunk applications

A bark penetrant such as Pulse[®] at a rate of 2% must be added to the mixture for trunk applications to work. For a 600 g/L phos acid product, mix at a rate of ½ phos acid, ¾ water and 2% penetrant. The solution must be continually agitated to ensure proper mixing. If the solution starts to gel, reduce the rate of the penetrant to 1.5%. Use approximately 250 ml per plant and apply to all sides of the trunk, about 1m up the trunk. Do not apply this concentration to leaves as it will burn them.

Metaxyl

Metalaxyl is a systemic fungicide with preventative and curative effects. It is registered as a soil application to help manage *Phytophthora* in macadamias. Soil organisms that breakdown metalaxyl build up quickly after application and reduce its efficacy, so it can only be used once or twice before it is ineffective. Metalaxyl has a withholding period of four weeks and should not be applied during harvest.

Conclusion

Macadamia orchards are being increasingly exposed to weather extremes because of climate variability. This will increase the susceptibility of Macadamia trees to *Phytophthora* diseases.

MARQUIS

An integrated approach, including improving orchard floor and drainage to reduce erosion and cover roots, improving soil health through mulch and compost applications and correctly timed chemical applications, is required for effective *Phytophthora* management.

Disclaimer

The contents of this publication are subject to copyright and may not be reproduced in any form without written permission from Marquis Macadamias Limited. This publication is intended to provide general information only and, while all care has been taken to ensure that the information contained in this publication is true and accurate, no responsibility or liability is accepted by Marquis Macadamias Limited or its staff for any claim which may arise from any person acting in reliance on the information set out in this publication.

For chemical recommendations, always check the label and product information prior to use. If the information you need is not on the label, either contact the reseller or manufacturer for the information or conduct a jar compatibility test. Remember that physical compatibility does not equal chemical compatibility. Ensure only registered and permitted products are used and the appropriate personal protective equipment is worn when mixing. All products listed are correct at the time of publishing.

Written in 2024 by: Mark Whitten, Simon Andreoli and Matt Weinert

For more information, contact our Grower Liaison Team:



Matt Weinert 0438 644 136



Mark Whitten 0429 826 510



Simon Andreoli 0401 710 810

Bundaberg: 07 4155 9377 · Lismore: 02 6624 3900