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Non-chemical management of myrtle rust in plant nurseries

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Contents

Executive summary 1

1 Introduction 2

2 Vulnerability of Myrtaceae species to myrtle rust 3

2.1 Highly vulnerable at any age 4

2.2 Most vulnerable as young seedlings..5

2.3 Vulnerable in high spore load situations 5

2.4 Myrtle rust seldom or never recorded in the natural environment 5

3 Non-chemical disease management 6

3.1 Features of myrtle rust biology 6

3.1.1 Outside sources of infection and spread within the nursery 6

3.1.2 Infection conditions and spore survival..6

3.1.3 Infection requires new growth 7

3.1.4 Temperature affects seasonal growth and latent period 7

4 Nursery management measures to reduce risk...8

5 Acknowledgements..8

6 References 9

Appendix 1. Species vulnerability to myrtle rust...10

Appendix 2. Seasonal and regional myrtle rust risk 11

Appendix 3. Seasonal and regional air temperatures 12

Executive summary

Non-chemical management of myrtle rust in plant nurseries

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May 2023

The greatest effect of myrtle rust since its arrival in New Zealand has been on the nursery industry, and disease control on vulnerable species in nurseries is necessary to ensure planting stock is free of infection. Certain fungicides can provide effective control of myrtle rust, but fungicide use is not always appropriate. If fungicides are not used, then non-chemical approaches to reduce disease risk are required. Even when fungicides are used, their effectiveness can be improved, and the risk of fungicide resistance reduced if disease risk is reduced by non-chemical disease management approaches.

Although the myrtle rust pathogen (*Austropuccinia psidii*) infects many plants in the Myrcateae (myrtle family), there is wide variation in its effect on different species and cultivars. Differences in species vulnerability greatly affect the intensity of myrtle rust management needed in the nursery.

This study describes non-chemical control measures nurseries can use to reduce myrtle rust risk and the biological rationale on which they are based. This includes information on vulnerability of key Myrtaceae species, including changes in vulnerability that occur as leaves and stems age and changes in some species as plants mature from small seedlings to larger trees. The non-chemical risk reduction measures outlined are based on sources of infection, *A. psidii* spore biology, climatic conditions required for infection and effects of seasonal and regional temperature on plant growth and pathogen development. Nursery managers need to understand how myrtle rust management requirements vary with different myrtle species/cultivars, and how region and season affect myrtle rust risk. A chart, intended as a tool for nursery managers, is included to summarise non-chemical management measures that can be applied in nurseries to reduce disease risk in different situations.

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1 Introduction

Myrtle rust, caused by the fungal pathogen *Austropuccinia psidii*, was first detected in New Zealand in 2017 and only infects plants in the myrtle family (Myrtaceae). It causes damage to leaves, stems flowers and fruit, death of shoots and sometimes plant death.

The nursery industry in New Zealand was severely affected after myrtle rust first arrived because of government measures required during the incursion response under the Biosecurity Act 1993 (Beresford et al. 2019a). Myrtle rust presents an ongoing biosecurity problem for nurseries because the law requires planting stock to be completely free of *A. psidii* when it leaves the nursery.

Not all Myrtaceae can be infected by myrtle rust and, for those that are, infection can only occur on young actively growing shoots. Vulnerability to myrtle rust varies between genera, species, and even within species, and impacts range from severe leaf and stem disease and shoot dieback to only occasional symptoms or no symptoms at all.

Some species are more vulnerable as young seedlings, whereas older plants are less affected. This occurs, for example, in *Metrosideros excelsa* (pōhutukawa) and *Leptospermum scoparium* (mānuka), and the reason it occurs is poorly understood. For *Eucalyptus grandis* in Brazil (Furtado et al. 2023), it was thought to be associated with anatomical changes in leaves as they age. However, it may also be associate with changes in phytohormones within the plant that control growth and development (Beresford et al. 2020).

Fungicides can provide effective control of myrtle rust in vulnerable species, but their use is not always appropriate, and some nursery managers are philosophically opposed to using them. If fungicides are not used, then non-chemical approaches to reduce disease risk are required. Even when fungicides are used, their effectiveness can be improved, and the risk of fungicide resistance reduced if disease risk is reduced by non-chemical approaches. Whereas fungicides can be used tactically in response to changes in disease risk during a season, non-chemical disease management approaches tend to be more strategic and require prior planning to incorporate them into nursery operations.

New Zealand Plant Producers Incorporated (NZPPI) currently give advice on myrtle rust control using fungicides and non-chemical means (NZPPI 2023a). More detailed information on risk-based fungicide management has been developed by The New Zealand Institute for Plant and Food Research Limited (PFR 2022), in conjunction with HortPlus Limited. This current project provides more detailed consideration of non-chemical disease management and how the vulnerability of different native and exotic Myrtaceae species affects the intensity of myrtle rust management required in nurseries.

2 Vulnerability of Myrtaceae species to myrtle rust

Vulnerability and disease management requirements. With wide variation in the effect of myrtle rust between species, the choice of which species or cultivars to produce has an overriding effect on the intensity of disease management required. Clearly, myrtle rust can be avoided by only producing Myrtaceae that are not vulnerable, or even not producing Myrtaceae at all. However, for New Zealand native myrtles, some of the most at-risk species are our most culturally and economically important, e.g., pōhutukawa and mānuka, and some are amongst our rarest, e.g., *Syzygium maire* (maire tawake; swamp maire).

Changes in vulnerability with plant age. For species that are more vulnerable as young seedlings than as older plants, e.g., pōhutukawa, mānuka and Bartlett's rātā (*Metrosideros bartlettii*), producing them under a disease management programme in the nursery knowing rust impacts will diminish after they are planted out offers hope for their continued use in revegetation plantings. This is extremely important for long-term maintenance of species biodiversity in our native ecosystems. For these species, it is not currently known whether they will also show a transition towards resistance with plant age if they are produced from cuttings or tissue culture derived from mature plant tissues.

Information on species genetic susceptibility. Comprehensive information for plant producers on the inherent genetic susceptibility/resistance of species and cultivars is lacking. Instead, vulnerability must be inferred from field observations in nurseries and natural areas, however, this must be done with caution because, in addition to a plant's genetic makeup, vulnerability is influenced by:

- Presence of new growth flush
- Age of plants
- Proximity to other infected plants
- Suitability of local climatic conditions
- Whether myrtle rust has established in the area.

Results from Australia (Smith et al. 2020), where seedlings of selected New Zealand native Myrtaceae were screened for genetic susceptibility/resistance under controlled conditions, gave a broad indication about which of the species tested were highly susceptible. However, for some species the results are difficult to interpret in relation to myrtle rust effects observed the natural environment in New Zealand. For example, *Kunzea* spp. (kānuka) was able to be infected as young seedlings by controlled inoculation, but myrtle rust has not been observed on this species in the wild. Similarly, many seed progeny of *L. scoparium* were severely infected, but myrtle rust is rarely observed in mature stands of natural and planted mānuka. For *M. excelsa*, almost no resistance was detected in seedlings under controlled inoculations, yet mature pōhutukawa trees in natural forests have so far been only sporadically affected by myrtle rust.

Appendix 1 contains a summary of observed vulnerability of key species. For a full list of myrtle rust host species recorded in New Zealand, see MPI (2023).

Below is the author's interpretation of the vulnerability of key species to myrtle rust, based on information from inoculation experiments, observations, and anecdotes. Species' vulnerability is given under four categories with notes for each on the disease management required in nurseries.

1. **Highly vulnerable at any age.** Most at risk from myrtle rust and need ongoing protection with fungicides and use of non-chemical measures to reduce infection risk.
2. **Most vulnerable as young seedlings.** At risk from myrtle rust and needing fungicide management and non-chemical measures, particularly as seedlings up to 2–3 years old. Vulnerability can vary widely between species and plant provenances, probably due to variation in genetic susceptibility.
3. **Vulnerable in high spore load situations.** Require a moderate degree of disease management including non-chemical measures, routine monitoring for disease and fungicides to protect some species.
4. **Myrtle rust seldom or never recorded in the natural environment.** Require little or no myrtle rust management required but should still be monitored for myrtle rust in the nursery.

2.1 Highly vulnerable at any age

- ***Syzygium maire.*** Native swamp maire (maire tawake) is highly susceptible to myrtle rust and there is currently no evidence of any plants with resistance, although this species has not been widely studied (Figure 1).
- ***Lophomyrtus spp.*** These are highly vulnerable, however, for *Lophomyrtus bullata* (ramarama) (Figure 1), resistant individuals have been found and their genetic resistance confirmed by controlled inoculation of cuttings. There have been no reports of resistance in *L. obcordata* (rōhutu; Figure 1).
- ***Syzygium australe.*** An Australian species (lilly pilly or eugenia) is popular as a hedge plant in the upper North Island. It is generally highly susceptible, although adjacent trees in hedge rows sometimes show marked differences in myrtle rust effects, suggesting variable genetic resistance. This has not been experimentally confirmed but could potentially be exploited to obtain resistant clones.
- ***Ugni molinae*** (Chilean guava) and ***Psidium guineense*** (Brazilian guava). These South American species are both vulnerable to myrtle rust.

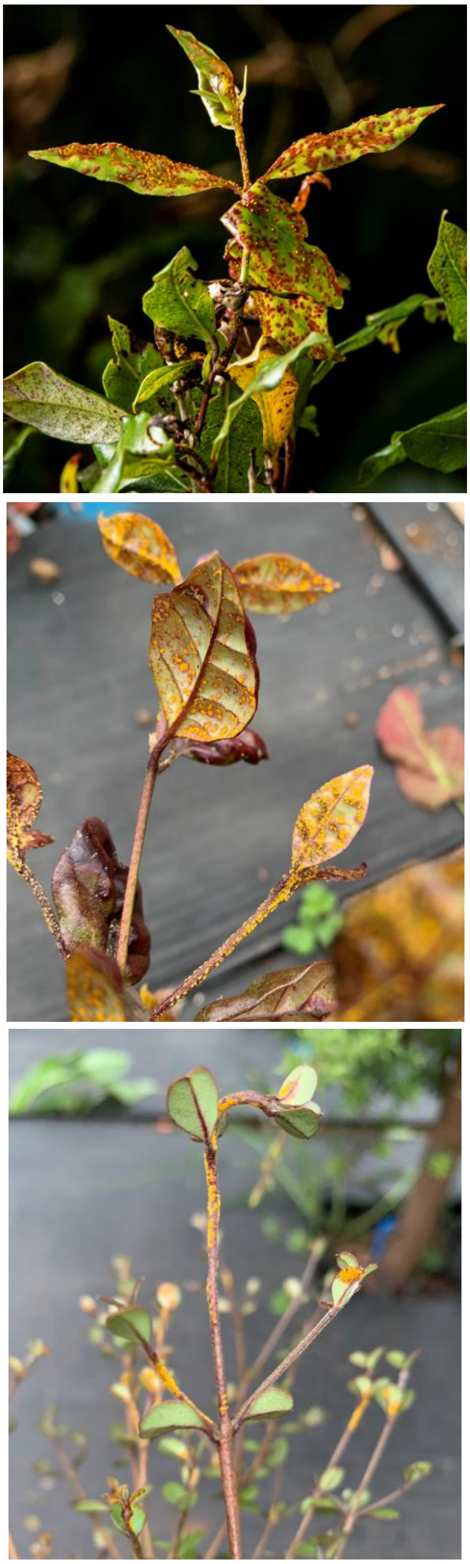

Figure 1. Myrtle rust on three highly vulnerable New Zealand native Myrtaceae species. From top to bottom: *Syzygium maire* (maire tawake, swamp maire), *Lophomyrtus bullata* (ramarama) and *L. obcordata* (rōhutu).

2.2 Most vulnerable as young seedlings

- ***Metrosideros excelsa*** (pōhutukawa) is attacked as young seedlings, whereas older trees (> 2-3 years old) are less affected. However, mature trees can show symptoms and the severity of these appears to be increasing year on year in the upper North Island. There appears to be variation in genetic susceptibility/resistance to myrtle rust between individual trees.
- ***M. robusta*** (northern rātā) and ***M. umbellata*** (southern rātā) appear to be largely unaffected by myrtle rust but there are reports of infection of young plants in nurseries. In the southern rainforests, susceptibility could be masked by climatic conditions unfavourable for myrtle rust.
- ***M. bartlettii*** (Bartlett's rātā)***.*** Nursery observations and controlled inoculations show some leaf infection of young seedlings but no stem infection. Older trees appear to be unaffected by myrtle rust.
- ***Eucalyptus* spp.** Some species show leaf and stem infection as young plants, but myrtle rust is seldom observed in older trees, although symptoms on epicormic shoots can sometimes be seen in situations of high spore load, e.g., urban areas where *S. australe* hedges are common.

2.3 Vulnerable in high spore load situations

- ***Leptospermum scoparium*** (mānuka) has occasionally been reported with myrtle rust on young seedlings in northern nurseries, but there are few reports on older trees. Fungicides are not routinely required in nurseries, but plants should be monitored for myrtle rust. There is one recorded instance of a low incidence of seed capsule infection in a high spore load experimental planting, suggesting potential genetic susceptibility. Neither the mānuka honey industry (Manuka Honey of NZ) nor Apiculture New Zealand (https://apinz.org.nz/about/) websites have any commentary about myrtle rust or information about the need for myrtle rust management.
- ***Metrosideros spp.*** (climbing rātā or aka vines). Infection is observed in native forests when vines are growing in close proximity to other more vulnerable species, e.g., *Lophomyrtus* spp. *M. carminea* (carmine rātā) appears to be more vulnerable than other climbing rātā species to myrtle rust and requires fungicide protection in the nursery.

  Callistemon spp. (bottle brush) and several other exotic species. Myrtle rust is sometimes observed on roadside trees in urban areas, where spore load is high. This is often associated with presence of nearby myrtle rust infected *S. australe*.

2.4 Myrtle rust seldom or never recorded in the natural environment

- ***Kunzea* spp.** There are no reports of myrtle rust on kānuka in the wild.
- ***Acca sellowiana*** Feijoa is recorded as a host but the Ministry for Primary Industries considers it not at risk from myrtle rust (MPI 2017) and there are no reports of it severely affecting either nursery plants or feijoa fruit production.

3 Non-chemical disease management

3.1 Features of myrtle rust biology

The ways in which *A. psidii* interacts with host plants and environmental conditions present opportunities for non-chemical approaches to reduce disease risk in nurseries. The features of myrtle rust biology to potentially be exploited for disease management are outlined in the following sections. However, it must be remembered the approaches suggested are largely theoretical and have not been evaluated in nurseries for their efficacy or practicality.

3.1.1 Outside sources of infection and spread within the nursery

For nurseries that follow biosecurity procedures to prevent myrtle rust importation, the main source of infection is spores carried by the wind from nearby infected plants. It is therefore important to identify and, if possible, remove any susceptible myrtle hosts within at least 500 m of the nursery boundary.

The number of myrtle rust spores in the air decreases rapidly with distance from an infected plant. Although a few spores can travel long distances, the vast majority are deposited less than half a metre from where they are released. The most important source of spores for new infections is therefore the closest infected plant (within or outside the nursery).

If myrtle rust arrives in the nursery, the risk of it spreading from plant to plant is greatly reduced if plant canopies are not touching each other. Plant spacing reduces risk in vulnerable species and will also help for more resistant species. Increased plant spacing may be impractical where production volumes are high.

3.1.2 Infection conditions and spore survival

Spores deposited on susceptible myrtle hosts can germinate and infect if there is a combination of high relative humidity (> 85%) for least 6 h and temperature above 10–12°C (Beresford et al. 2018). If conditions are warmer, and high humidity lasts for longer, more spores will infect more quickly. These conditions are most likely to occur at night but can also occur with rain or wetting from irrigation at other times. Information on current infection conditions is available in the NZPPI Disease Management Platform (NZPPI 2023b).

If conditions are too dry or too cold for spores to germinate, they may remain alive until the next time suitable conditions occur; however, ultraviolet light during the daytime is likely to kill these spores. If spores begin to germinate and the humidity drops before infection is complete, they will perish. Under natural conditions, spores live at most a few days and the increase in humidity each night will usually trigger an attempt at infection whether it is successful or not. Spores do not survive for long in the soil nor on non-host surfaces.

Infection risk in the nursery can be reduced by placing vulnerable plants in an area with greater air movement or providing fans to promote drying. Foliage wetting that encourages myrtle rust infection can be reduced by irrigating early in the morning on fine days to ensure foliage dries before humidity increases late afternoon. Drip irrigation rather than overhead sprinklers will greatly reduce foliage wetting. Use of a sterilant is recommended to decontaminate equipment that may be carrying myrtle rust spores. Suitable sterilants include methylated spirit diluted to 70% with water and 5% Sterigene.

3.1.3 Infection requires new growth

Myrtle rust cannot infect old leaves and stems, even on the most genetically susceptible host plants. Only young, actively expanding plant tissues are able to be infected and these change from susceptible to completely resistant at about the time they reach full size (Beresford et al. 2020). On an actively growing branchlet, this typically occurs at the fourth to fifth leaf pair below the top.

Because only new plant tissues are infected, risk of myrtle rust infection is greatest during periods of growth flush and the greater new growth there is, the faster myrtle rust will increase if infection establishes. Species vulnerable to myrtle rust that are not actively growing because of unfavourable conditions (e.g., low temperature, poor soil fertility, plant disturbance) cannot become infected. Nursery plant production, by its nature, encourages rapid growth, which makes myrtle rust risk inherently higher in nurseries compared with the natural environment.

The infection requirement for new growth means that infection risk can be reduced at critical times if growth can be managed. Fertilising and irrigating in early autumn will encourage new growth at a time when temperatures and myrtle rust activity are both decreasing. Conversely, limiting fertiliser use and irrigation in late spring and early summer will reduce growth flush during the high-risk summer period. Pruning or trimming of plants encourages growth flush and this should be done in autumn, as temperatures are cooling, rather than in spring or summer. In frost prone nurseries, new growth induced by autumn fertilising or pruning may increase the risk of frost damage. This can be managed with overhead watering or fans when temperatures are likely to fall below 0°C.

3.1.4 Temperature affects seasonal growth and latent period

Growing season. Seasonal plant growth is largely determined by local temperature. From late autumn, through winter and until spring, growth is relatively slow so there is little new flush available for myrtle rust to infect. This is the annual low risk period for myrtle rust and is longer in warmer northerns regions than cooler southern regions and at higher altitudes. Different myrtle species are adapted differently to warm or cool conditions, e.g., *Lophomyrtus* spp. are better adapted for growth at low temperatures than *M. excelsa* (Beresford et al. 2019b). Information on the growth response to temperature for other species is currently lacking.

Latent period. Myrtle rust multiplies on its host plants by repeated cycles of infection and spore production. An (inverse) indicator of multiplication rate is the latent period or generation time of *A. psidii* (time from infection to new spores). Multiplication is most rapid when the latent period is short (6–7 days at average temperatures above 20°C) and is slowest when the latent period is long (1–2 months at average temperatures of 10–12°C). Below 8–10°C, *A. psidii* development inside an infected plant stops altogether; however, it can survive inside the plant until temperatures warm up again (Beresford et al. 2020).

Daily latent period information for highly vulnerable species is available in the NZPPI Disease Management Platform online tool (NZPPI 2023b). This also reports the occurrence of infection conditions and can be used to identify high-risk periods when myrtle rust monitoring should be carried out in nurseries. In more resistant species, where the plant's physiology inhibits *A. psidii* development, the latent period is longer.

Seasonal and geographic risk. High myrtle rust risk is caused by warm seasonal temperatures allowing rapid plant growth, short latency and frequent infection events. The season of high risk is longest in the upper North Island (November – May) and it is shorter in the upper South Island

(December – February), and even shorter further south (Appendix 2). The short high-risk season further south limits the geographic spread of myrtle rust in New Zealand. Conversely, low myrtle rust risk occurs when conditions are too cold for myrtle rust, particularly when average daily temperatures remain below 12°C (Appendix 3).

4 Nursery management measures to reduce risk

Table 1 describes various risk situations for myrtle rust in nurseries and appropriate non-chemical measures to reduce risk based on myrtle rust biology and species vulnerability, as described above. These measures have the potential to reduce risk in both highly vulnerable and less vulnerable species and in both warm northern and cooler southern regions. The measures may also reduce reliance on fungicides for myrtle rust control and reduce the risk of fungicide resistance.

Table 1. Nursery situations affecting risk of myrtle rust establishing in vulnerable species, with measures to reduce the risk and cross references to the biological rationale for each measure.

	Risk situation	Risk reduction measure	Rationale
1	**Infected myrtle plants producing yellow myrtle rust spores have been seen nearby.**	Remove all unnecessary susceptible myrtle hosts on the property. Survey within 500 m (or more) of the property for susceptible hosts and if possible have them removed.	Outside sources of infection and spread within the nursery
2	**Myrtle rust has arrived unnoticed in the nursery.**	Monitor vulnerable species every 1–2 weeks during the high-risk season for early detection of symptoms. Follow removal procedures if myrtle rust is found (Myrtle rust nursery management protocol).	Outside sources of infection and spread within the nursery
3	**Closely spaced plants with foliage touching.**	Increase spacing between vulnerable plants so foliage is not in contact to reduce the rate of myrtle rust spread and to allow easier detection of symptoms.	Outside sources of infection and spread within the nursery
4	**Plants in a humid place with little air movement and prolonged wetness.**	Move plants to an area with greater air movement (wind) or provide fans to promote drying.	Infection conditions and spore survival
5	**Foliage wetting occurs in the afternoon or evening and continues all night.**	Avoid foliage wetting that encourages myrtle rust infection. Irrigate early morning on fine days to ensure foliage dries before humidity increases late afternoon. Install drip irrigation as opposed to overhead sprinklers.	Infection conditions and spore survival
6	**Plants have a strong flush of new growth.**	Avoid promoting excessive new growth in late spring and summer when warm temperatures favour infection. Withhold fertiliser applications until autumn and limit irrigation during summer. Do not prune or trim during spring and summer. *[Caution: If promoting growth flush in autumn, frost protection may be required]*	Infection requires new growth; Temperature affects seasonal growth and latent period
7	**Know how to identify periods of low risk during cold weather.**	Monitor for average daily temperatures mostly below 12°C as an indicator of when myrtle rust development is very slow. Rust development stops at average daily temperatures below about 10°C. See (Myrtle Rust Daily Risk) for current information on infection risk and latent period.	Temperature affects seasonal growth and latent period

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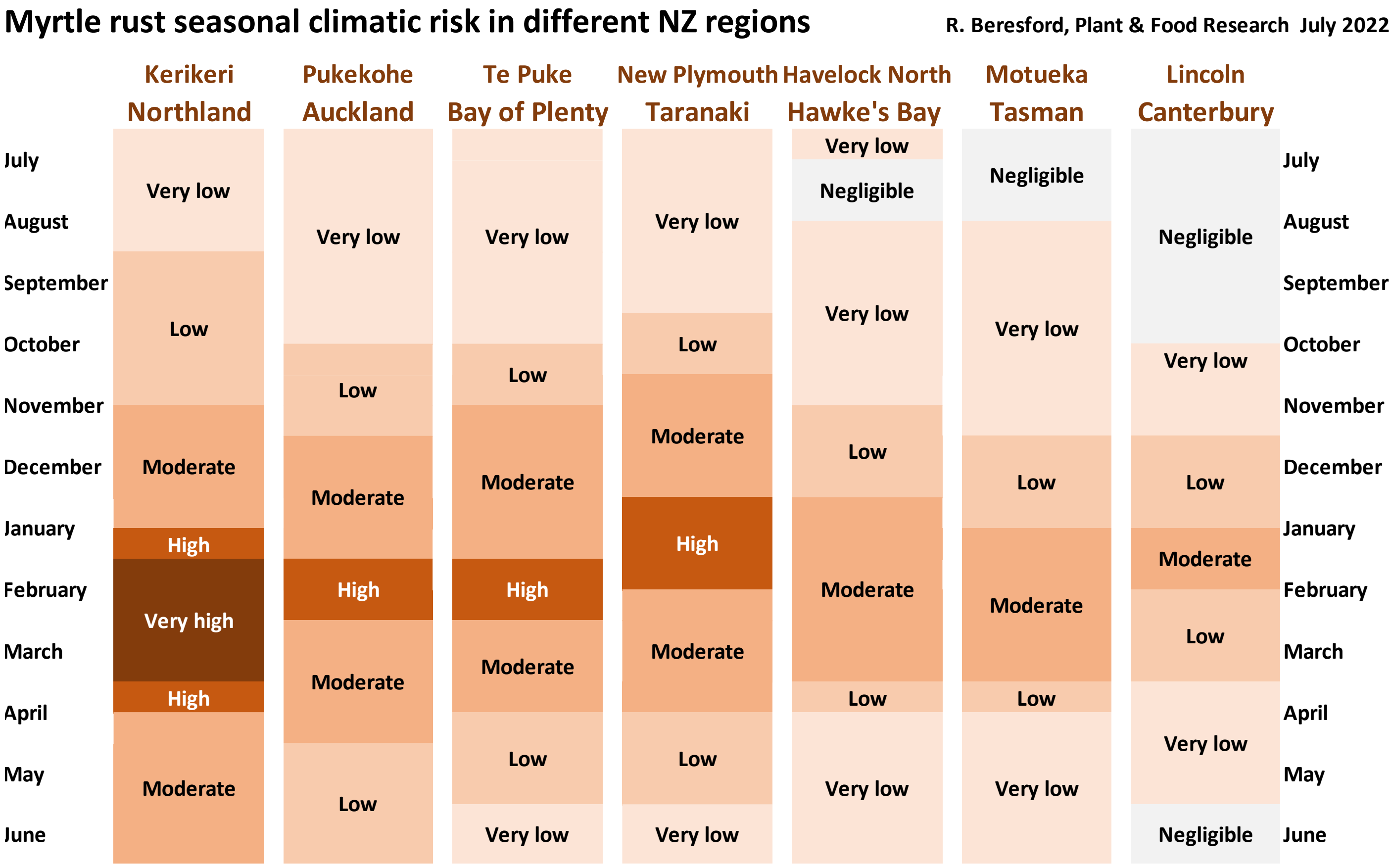
Appendix 1. Species vulnerability to myrtle rust

Vulnerability of New Zealand myrtles to myrtle rust — **R Beresford, Plant & Food Research – May 2023**

Common name	Botanical name	Severe infection commonly seen	May be severe on young seedlings or basal growth of older trees	When growing near more susceptible species	Infection seldom seen in the natural environment	Infection not confirmed in the natural environment
Native species						
*Maire tawake; swamp maire	*Syzygium maire*	✓				
*Ramarama	*Lophomytus bullata*	✓	(Includes *L. bullata* x *L. obcordata* hybrids)			
*Rōhutu	*Lophomytus obcordata*	✓				
Pōhutukawa	*Metrosideros excelsa*		✓	(Rust on mature trees is becoming more common)		
Carmine rātā	*Metrosideros carminea*			✓		
Colenso's rātā	*Metrosideros colensoi*			✓		
White rātā	*Metrosideros perforata*			✓		
White rātā	*Metrosideros diffusa*			✓		
Scarlet rātā	*Metrosideros fulgens*			✓		
Climbing rātā (other)	*Metrosideros spp.*					✓
Bartlett's rātā	*Metrosideros bartlettii*		✓			
Southern rātā	*Metrosideros umbellata*				✓	
Northern rātā	*Metrosideros robusta*				✓	
Mānuka	*Leptospermum scoparium*	(Young mānuka seedlings may become infected)			✓	
Kānuka	*Kunzea spp.*					✓
Exotic species						
Lilly pilly, eugenia	*Syzygium australe*	✓				
Guava	*Psidium guajava*	✓				
Chilean guava	*Ugni molinae*	✓				
Feijoa	*Acca sellowiana*				✓	
Brush cherry	*Syzygium paniculatum*					✓
Monkey apple	Syzygium smithii					✓
Eucalypts	*Eucalyptus* spp.		✓	(Vulnerability varies between species)		

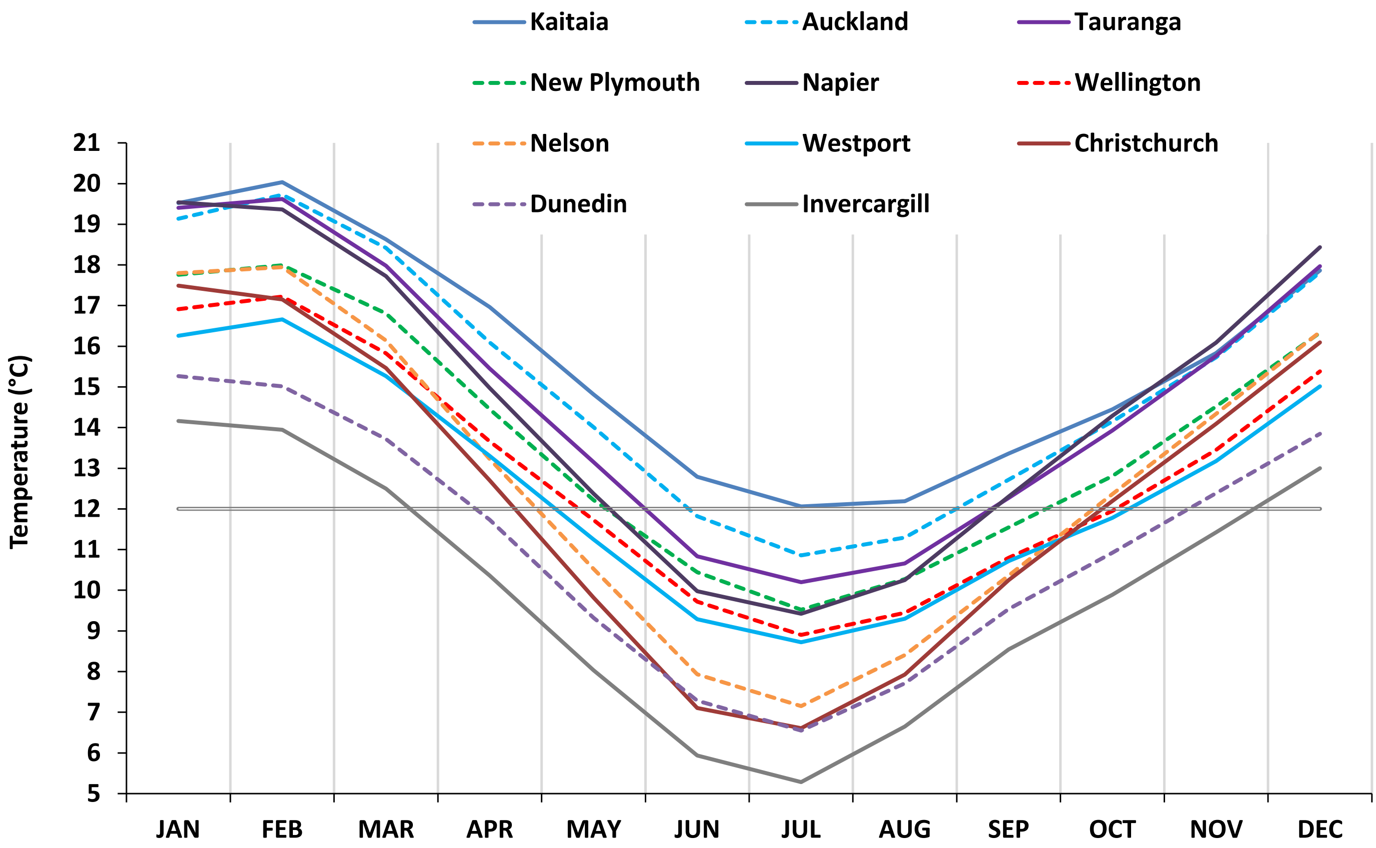
*These species are the most vulnerable and are severely attacked as both seedlings and mature plants

Appendix 2. Seasonal and regional myrtle rust risk



Appendix 3. Seasonal and regional air temperatures

Mean monthly air temperature at selected locations across New Zealand showing when and where mean winter temperatures less than 12°C occur. Data are from the National Institute of Water and Atmospheric Research (modified after Beresford & Wright 2022).



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