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Overview of myrtle rust since its arrival

An unwelcome "guest"

May 2022 marks the 5th anniversary of the arrival of *Austropuccinia psidii* (myrtle rust) to the New Zealand mainland. Myrtle rust is a significant disease of plants in the myrtle family (Myrtaceae) that originates from South America. Following detection in New Zealand, the Ministry for Primary Industries (MPI) immediately initiated a rigorous incursion response, but the pathogen continued to spread and is now widely established. The disease threatens myrtles of economic, environmental and socio-cultural importance. Here we reflect on the research Scion has contributed to better understand and manage this disease.

Active myrtle rust infection on Lophomyrtus bullata *and* Metrosideros diffusa.

Research Accord

The New Zealand Government has funded research through the Ministry for Primary Industries (MPI), the Department of Conservation (DOC), Regional Councils and several Ministry of Business, Innovation and Employment (MBIE) research programmes, including Beyond Myrtle Rust: Towards Ecosystem Resilience, Ngā Rākau Taketake (NRT), the Catalyst Fund and the Strategic Science Investment Fund (SIFF). Research has been highly collaborative, involving mana whenua, Crown Research Institutes, such as Scion, Plant & Food Research (PFR) and Manaaki Whenua Landcare Research (MWLR), as well as several universities and international collaborators.

Host susceptibility

Understanding whether resistance to disease is present in host populations is key when developing management and conservation strategies. Scion, in collaboration with PFR, the Queensland Department of Agriculture and Fisheries (QDAF), and others, assessed the susceptibility of pōhutukawa (*Metrosideros excelsa*), mānuka (*Leptospermum scoparium*), ramarama (*Lophomyrtus bullata*), rōhutu (*Lophomyrtus obcordata*), kānuka (*Kunzea robusta*), and rawiri mānuka (*Kunzea linearis*) seedlings under controlled conditions. Ramarama, rōhutu, and pōhutukawa were all highly susceptible. Susceptibility varied considerably among provenances for the other species.[1] These findings identified species most at threat, provided insight into resistance mechanisms and informed further research.

Field trails were an important next step in host susceptibility testing to determine vulnerability under natural conditions. Scion in collaboration with PFR studied disease development in field trials in Rotorua and Auckland. Ramarama, rōhutu, and pōhutukawa are all highly susceptible under field conditions at both locations, whereas kānuka and mānuka are more resistant, with only a low incidence of disease observed on mānuka fruit. Disease severity is greater in Auckland, with active infection present through winter, in comparison to the colder Rotorua site.

Surveillance and monitoring of the disease

Surveillance and monitoring in native forest has further demonstrated the threat to susceptible hosts. Tracking the disease through time in natural populations has strengthened our understanding of the seasonal nature of myrtle rust epidemics and their close association with periods of host growth and reproduction. Scion researchers have monitored disease impacts and changes in tree health in the Bay of Plenty, Auckland and Taranaki. At sites where the pathogen is well established, the disease has had a significant impact on growth and reproduction of *Lophomyrtus*.[2] At sites that were initially free from disease, a gradual increase in disease has been observed.

Symptoms have also been recorded on myrtles co-occurring with the highly susceptible *Lophomyrtus* species, such as climbing rātā (*Metrosideros diffusa*, *M. fulgens* and *M. perforata*). The current impact on climbing rātā is usually relatively low; however, severe disease has been reported from plants in close proximity to heavily infected hosts. Auckland University Masters' student Ngaio Balfour, based at Scion, is investigating the link between disease severity on rātā and maire tawake in proximity to symptomatic *Lophomyrtus* trees.

Continued monitoring of the disease across the entire country will require additional tools. Scion has worked on the development of deep learning models that use aerial imaging to identify and map host species.[3] These tools will support forest health monitoring and future biosecurity responses.

Disease control strategies

Chemical and biological control options are needed to help manage myrtle rust in the near and long-term. Scion has trialled different chemical options, including the addition of different adjuvants to improve fungicide delivery across leaf surfaces. Vandia®, Flint®, and Sercadis® have shown promise as chemical treatments, while adjuvants such as Actiwett® and Radial® have significantly improved the distribution of these fungicides over leaf surfaces.[4] While fungicides can be an important management tool in certain situations, their use to protect trees in natural settings will often not be practical.

To better inform further research efforts in this area, Scion, in partnership with New Zealand Plant Producers Incorporated

(NZPPI), will soon survey nurseries to identify which myrtle species are stocked, what impact myrtle rust has had, and which control tools and methods are currently used. This research will identify the needs of nurseries and identify knowledge gaps for future research.

Natural enemies

Natural enemies may play an important role in reducing inoculum pressure in the environment. During fieldwork, small fly larvae (Cecidomyiidae) are often observed feeding on myrtle rust. This fly is being formally described as a new species. Scion, working with MWLR, have started to investigate the potential host range and distribution of *Mycodiplosis* in New Zealand by inspecting rust specimens curated in herbaria.

A Mycodiplosis *spp. larvae on* L. obcordata *leaf with myrtle rust symptoms from Awhitu Peninsula.*

Pathogen adaptability and life cycle

Understanding the life cycle of the pathogen is important for long-term management. Researchers at Scion are working to fill gaps in our knowledge about the life cycle of *A. psidii* with collaborators at the University of Queensland and QDAF. An assessment of the genetic diversity of New Zealand populations of *A. psidii* is underway. The sexual stage has been observed in all established populations and is more abundant between January to March. Where sexual reproduction occurs, even in small amounts, populations are expected to have greater genotypic diversity that may make them more adaptable. Scion is undertaking controlled trials to investigate potential environmental and host drivers of sexual reproduction. This is important to understand what could happen if a new strain of *A. psidii* were to arrive in New Zealand.

Threat of other strains

Multiple strains of *A. psidii* have been identified, but only the "pandemic strain" is currently present in New Zealand. To examine the threat of strains currently outside of New Zealand, Scion has partnered with international collaborators including the Forestry and Agricultural Biotechnology Institute (FABI) in South Africa and the Facultdad de Agronomica in Uruguay. Pōhutukawa, mānuka, kānuka, and rawiri mānuka, were sent to collaborators to be tested under controlled conditions. All species were found to be susceptible, with mānuka and pōhutukawa the most susceptible, and kānuka the least susceptible to the South African[5] and Eucalyptus (Uruguay)[6] strains. These findings highlight the need for continued biosecurity measures to keep additional strains of the pathogen out of New Zealand. To support this, Scion is working with PFR and Colorado State University to develop a new diagnostic test capable of distinguishing between different strains.

Social science understanding impacts and values

Scion's social researchers are working within NRT on human impact, engagement and values underlying our responses to myrtle rust. Understanding impacts from a whole system perspective across social and cultural values, as part of economic and environmental consequences, is part of the work being co-led by Scion with the University of Auckland. Together, we are supporting researchers in thinking more holistically about our responses to plant pathogens; building capacity to better assess and address cross-cutting issues of plant pathogens on people and the environment. Other project work is focussing on the conceptual shifts needed to accommodate working across different knowledge systems, with a focus on colonial biases in the way we understand plant pathogens and how we resource our responses to them. Resources are being developed to help engage with people impacted, including different strategies for raising awareness and interventions for monitoring and mitigating impacts.

Where are we now?

It is clear that the New Zealand climate is favourable to *A. psidii*, with the pathogen well established on susceptible myrtle species in native forests, nurseries and urban settings across the country. Some myrtle species are more susceptible than others, and the task now is to find ways of effectively managing the disease to ensure the survival of these species. Part of that requires that we continue to engage communities, particularly Māori, as species and environments impacted are taonga.

Scion has already begun doing that. We are leading a Jobs for Nature-funded project, Myrtle Rust Jobs for Resistance programme Te Rara Whakamaru being delivered in partnership with the Rotoiti 15 Trust. Working with mana whenua in the Bay of Plenty region, a team of eight trained kaimahi are surveying and monitoring the spread of myrtle rust, reporting on tree health, and identifying potential disease resistance. The project is developing knowledge of myrtle rust impact in native forest and contributing to a culturally appropriate conservation strategy to protect our most at-risk species.

What can you do?

Further resources can be found at https://www.myrtlerust.org.nz.

If you observe myrtle rust, please report it at https://www.inaturalist.org/projects/myrtle-rust-reporter

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[6] Unpublished data

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