Risk Management Proposal:
Myrtaceae nursery stock from all countries.
Specific measures for the *Puccinia psidii* complex (Guava rust and Myrtle rust).

FOR PUBLIC CONSULTATION

June 2011

Plant & Plant Product Imports
Import & Export Standards Directorate
Ministry of Agriculture and Forestry
Pastoral House
25 The Terrace
PO Box 2526
Wellington 6011
New Zealand

Tel: +64 4 894 0170
Fax: +64 4 894 0662
Email: plantimports@maf.govt.nz

TABLE OF CONTENTS

Summary 3
Purpose 4
Background 4
Objective 4
Analysis of the *P. psidii* biosecurity risk and management options 4
1. Commodity 4
2. Pest Description 5
2.1 Distribution of *Puccinia psidii* 5
2.2 Host range 5
3. MANAGEMENT OF RISK 7
3.1 Requirements of the current Nursery Stock IHS standard 7
3.2 Efficacy of the current IHS requirements for managing the increased biosecurity risk ..... **Error! Bookmark not defined.**
3.3 Additional management options to consider 8
3.3.1 Pest Free Area ..... **Error! Bookmark not defined.**
3.3.2 Fungicidal Treatment ..... **Error! Bookmark not defined.**
3.3.3 Additional conditions for Tissue Culture 10
4. PROPOSED AMENDMENTS TO THE STANDARD 10
REFERENCES 13
Appendix 1: Myrtaceous genera with species susceptible to *Puccinia psidii* ... 15

Summary

MAF is proposing a number of changes to the import requirements for Myrtaceae nursery stock, under the import health standard (IHS) 155.02.06: Importation of Nursery Stock. The import requirements were reviewed because both the distribution and the host range of *Puccinia psidii* has rapidly expanded in the past 15 months.

The Guava rust fungus (*Puccinia psidii)* has the potential to cause moderate to high economic, environmental and socio-cultural impacts in New Zealand.

Puccinia psidii is a native of Central and South America, but is also known to be present in the United States of America (Florida, California, and HawaiÊ) and the Antilles (Cuba, Jamaica, and Trinidad and Tobago). Most recently, *Uredo rangelii* (a species within the *Puccinia psidii* complex, which has been given the common name Myrtle rust) was identified in Australia in 2010.

Since being identified in Australia, the known host range of *Puccinia psidii* has expanded considerably, from 21 to 35 Myrtaceae genera susceptible to infection (Appendix 1). In New Zealand there are many iconic native species in the Myrtaceae family, such as pohutukawa and rata (*Metrosideros* sp.) and manuka (*Leptospermum* sp.), as well as the economically important *Eucalyptus* and Feijoa (*Acca sellowiana*).

This Risk Management Proposal provides justification for the proposed amendments to the IHS to manage the risks posed by *P. psidii.* It is proposed that the two schedules *Agonis* and *Acca sellowiana* (feijoa) be amalgamated under the *Metrosideros* schedule, which will include all Myrtaceae genera currently eligible under *Agonis, Acca sellowiana, Metrosideros* and those covered under the Basic conditions. The schedules for *Eugenia* and *Eucalyptus* will continue to be maintained as separate schedules, as these cover additional pests to *Puccinia psidii*.

The post-entry quarantine (PEQ) requirements for whole plants and cuttings have been amended to require Level 3 facilities, to ensure that structural and operational measures are in place to prevent the escape of spores which may be present on infected foliage. The PEQ period has also been extended to 6 months in the *Metrosideros* schedule.

Tissue cultures are a lower risk pathway compared to whole plants and cuttings. However the current requirements for tissue culture in the IHS are not considered sufficient to manage the low risk of contamination with *P. psidii* spores. As *P. psidi*i favours young, actively growing tissue and high humidity, visible disease symptoms are expected to be apparent within 12 days of contamination, if the plantlets are actively growing and maintained at temperatures between 15 to 23 ·C. If tissue cultures have spent a period of at least four weeks in the same media prior to export, they may be given biosecurity clearance on arrival in New Zealand provided the phytosanitary certificate is endorsed with the specific additional declaration. If this additional declaration is not endorsed on the phytosanitary certificate, the tissue cultures must be imported under a permit to import into a Level 3 PEQ tissue culture laboratory for a period of 4 weeks.

Purpose

The purpose of this document is to:

- update the distribution of *Puccinia psidii* and the known host species,
- describe the likelihood that *P. psidii* could be accidentally introduced into New Zealand on imported nursery stock,
- recommend appropriate import measures to mitigate the risk of *P. psidii* in nursery stock,
- Seek stakeholder feedback on the recommended management options and import requirements.

Background

There are currently specific measures for the rust fungus *Puccinia psidii* under five schedules in the nursery stock IHS 155.02.06: Importation of Nursery Stock - *Acca, Agonis, Eucalyptus, Eugenia* and *Metrosideros*. In addition, there are currently 62 other Myrtaceae species that are eligible for import under the Basic Conditions with no specific measures for *P. psidii*.

In April 2010, a member of the Guava rust complex (*Uredo rangelii*) was found on Myrtaceae species in Australia, expanding the known distribution and the range of host species the fungus infects. Since April 2010, MAF has suspended the issuance of permits for Myrtaceae whole plants and cuttings from Australia, and is considering requests to import Myrtaceae whole plants and cuttings from other countries on a case by case basis. Myrtaceae tissue cultures are still eligible for import.

The rust has an extremely broad host range, which now includes plants from 35 genera of Myrtaceae. It is now known to infect *Lophomyrtus* and *Metrosideros* species in Australia, both of which have species in New Zealand. Should it arrive here, it is expected to spread rapidly and easily, affecting many of our iconic native species. Due to its biology, eradication would be impossible, as was the experience in Hawaii and Australia (Killgore & Heu, 2007; Loope & La Rosa, 2008; Eyles & Burnip 2010).

The current IHS does not have provisions for regulation of *P. psidii* on many of these newly described hosts and the IHS needs to be updated to manage the risk for imported nursery stock from countries where *P. psidii* is present.

Objective

The objective of the proposed measures is to effectively manage the biosecurity risk of *Puccinia psidii* on imported nursery stock, in a way that is consistent with New Zealandís domestic legislation and international obligations.

Analysis of the *P. psidii* biosecurity risk and management options

1. Commodity

Nursery stock of approved Myrtaceae plant species are listed on the MAF Plants Biosecurity Index, and may be imported into New Zealand as nursery stock (whole plants, cuttings, and tissue culture) under the import health standard (IHS) 155.02.06: Importation of Nursery

Stock. Since January 2005, all imports of Myrtaceae whole plants and cuttings have been sourced from Australia, while tissue cultures of Myrtaceae have been sourced from Australia, India, and the United States of America.

Myrtaceae nursery stock can be imported as whole plants or cuttings, or as tissue cultures, under the following five schedules, as well as 62 species under the Basic Conditions:

- *Acca sellowiana* (feijoa)
- *Agonis*
- *Eucalyptus*
- *Eugenia*
- *Metrosideros*

2. Pest Description

Puccinia psidii is a rust fungus which infects plants exclusively within the family Myrtaceae. The plant disease it causes is known as guava rust, eucalyptus rust, Oĥia rust or myrtle rust. Symptoms of the disease begin as small, golden-yellow, powdery eruptions in a circular pattern on the leaf or stem. These spots expand and become necrotic, spreading over the entire leaf, stem or shoot, and can affect floral buds and fruit also. Leaves and stems become deformed and growing tips can die back in severe infections (Killgore & Heu, 2007).

P. psidii spores can be spread by rain, insects (e.g. honeybees (Carnegie *et al.* 2010)), and wind. Eradication is technically exceedingly difficult once established in the environment (NSW Department of Primary Industries, 2010).

2.1 Distribution of *Puccinia psidii*

Puccinia psidii originates from Brazil and has since been found in Central and South America, and in the USA (Florida since 1977, California since at least 2005, Hawaii since 2005). It was recently found in Japan (Kawanishi *et al.* 2009). It was reported in Taiwan (Wang, 1992) but has not been found since 1992. In all of these locations *P. psidii* affects only species of the family Myrtaceae.

P. psidii was discovered in New South Wales in Australia in April 2010, and subsequently in Queensland in December 2010.

The fungus has been recorded to be present in the following countries (CABI 2010):

- **Asia:** India, Taiwan, Japan
- **North America:** Mexico, USA [HawaiĤ, Florida, California],
- **Central America:** Costa Rica, Cuba, Dominica, Dominican Republic, El Salvador, Guatemala, Jamaica, Puerto Rico, Trinidad and Tobago,
- **South America:** Argentina, Brazil, Amazonas, Espirito Santo, Pernambuco, Sao Paulo, Colombia, Ecuador, Paraguay, Uruguay, Venezuela,
- **Oceania:** Australia (New South Wales, Queensland).

2.2 Host range

The *P. psidii* complex is unique among rusts in that it has an extremely wide host range within the Myrtaceae family. Myrtaceae is a large family of plants, containing about 155 genera and over 3000 species, predominantly distributed in the southern hemisphere

(Govaerts & Lucas, 2008; Wilson *et al.* 2001). The arrival of *P. psidii* in Hawaii resulted in a rapid increase in known hosts. In Australia, it is currently known in 101 host species and 44 genera (as at 13 June 2011; up from 69 species and 35 genera as of 9 May 2011: NSW Department of Primary Industries, 2011). The tally is expected to continue to expand as the rust spreads further in the Australian environment.

The potential for new hosts in Australia is extremely high because it is the centre of Myrtaceae biodiversity, being home to 70 genera and 1646 species of native Myrtaceae, approximately half of the worldÊs Myrtaceae species (Glen *et al,* 2007). Therefore all Myrtaceae species are considered to be potential hosts.

2.3 Summary of the biosecurity risk of *P. psidii* on nursery stock

The biosecurity risk of *P. psidii* on nursery stock imports to New Zealand has been assessed by MAF.

Likelihood of Import into New Zealand

In the pest risk assessment, the likelihood of *P. psidii* entering New Zealand on Myrtaceae nursery stock was considered as moderate to high because:

- Myrtaceae nursery stock is only routinely imported from countries where *P. psidii* is known to occur (i.e. Australia and USA);
- At least one country, Hawaii, is thought to have received *P. psidii* via nursery stock importation;
- Plant nurseries have in the past been unknown reservoirs of *P. psidii*;
- Plant nurseries in countries where *P. psidii* is established are likely to harbour *P. psidii* from time to time;
- Whole plants or cuttings can be readily contaminated with *P. psidii* spores or intracellular mycelia prior to export;
- Plants *in vitro* (i.e. tissue culture) have a very low likelihood of being contaminated with *P. psidii* spores or intracellular mycelia, but if they were they could enter New Zealand before symptoms became apparent;
- Established infections would be easily detected at pre-export quality inspections, but early-stage infections or individual *P. psidii* spores could go undetected at inspection;
- Invisible *P. psidii* contaminants on nursery stock are likely to be viable because transportation to New Zealand takes less than a day and urediniospores are viable for up to 150 days.

Likelihood of Finding Suitable Hosts in New Zealand

In the pest risk assessment, the likelihood of *P. psidii* being transferred to a new host in New Zealand was considered as high because:

- Nursery stock are initially planted and placed next to other suitable hosts of *P. psidii* in nurseries; and there is also a wide availability of suitable hosts outside the nursery;
- Climatic conditions in nurseries are suitable for the germination and infection by contaminating *P. psidii* spores;
- An actively growing nursery stock plant with a primary infection would produce new urediniospores within 12 days;
- Urediniospores are easily dispersed by wind, rain, insects and by human assistance.

Likelihood of Establishment in New Zealand

In the pest risk assessment, the likelihood of *P. psidii* being able to establish and spread in New Zealand was considered as high because:

- The New Zealand climate, particularly in the North Island is suitable for *P. psidii*;
- There are many natural and modified habitats in New Zealand, occurring in suitable climate areas, that could support the biology of *P. psidii*, including amenity plantings, plantations and New ZealandÊs native scrub and forests containing Myrtaceae species;
- All Myrtaceae species are considered potential hosts of *P. psidii* because the experience of Hawaii and Australia demonstrates that it affects hosts not previously predicted and it is likely to behave the same in NZ;
- The experience of Australia and Hawaii demonstrates that, once established beyond a confined area, it is highly likely that eradication will be technically unfeasible;
- *P. psidii* spores are easily spread and the disease has spread fast when it has arrived in other new locations (e.g. Australia; Hawaii);
- The rate of spread of *P. psidii* is influenced by the severity of Myrtaceae infections and the consequent spore inoculum loading.

Likelihood of Economic and Environmental Consequences in New Zealand

In the pest risk assessment, if *P. psidii* became established in New Zealand it would be considered to have moderate to high economic, environmental and socio-cultural impacts because:

- It has the potential to cause direct mortality to New ZealandÊs native forest plant species in the family Myrtaceae, including *pohutukawa, manuka, kanuka* and *rata*;
- Myrtaceous species have a large influence on the structure, composition and function of New ZealandÊs indigenous ecosystems, so any change in the fitness of these species could have cascading effects through these ecosystems;
- If *manuka* is moderately susceptible to *P. psidii*, the manuka honey industry could be negatively affected;
- It could negatively affect the feijoa (*Feijoa sellowiana* or *Acca sellowiana*) industry, with commercial production for domestic and export markets.
- It could adversely impact the *Eucalyptus* timber, log, and pulp industries.

3. MANAGEMENT OF RISK

In order to provide a practical way of dealing with a host range which is still undergoing expansion, the risk management measures for *P. psidii* on nursery stock will apply to all genera of Myrtaceae, as they are all regarded as potentially susceptible to *P. psidii*.

3.1 Basic conditions of the Nursery Stock IHS standard

There are currently 539 species of Myrtaceae eligible for import into New Zealand as nursery stock. Of these, 62 species are only required to meet the Basic Conditions, with no specific requirements for *P. psidii.* The other 477 species were previously determined by MAF to be hosts or potential hosts of *P. psidii*, and specific measures for *P. psidii* are required under the schedule, either prior to export or while in PEQ.

Myrtaceae plants can be imported as whole plants or cuttings, or as tissue cultures. Each type of nursery stock import has different risks associated with it.

Whole plants or cuttings: *P. psidii* attacks young actively growing leaves, shoots, floral buds and fruits. Therefore, Myrtaceae whole plants or cuttings could conceivably be contaminated with *P. psidii* spores through exposure to an infected source plant. Under the current import health standard, the Basic Conditions for whole plants and cuttings (section 2.2.1) reduce some, but not all, of the risk of *P. psidii* entry and establishment. These are:

- Cleanliness: plants must be packaged in inert/synthetic material and free from soil and other extraneous matter.

- Pre-export phytosanitary inspection: prior to issuing a phytosanitary certificate, the exporting National Plant Protection Organisation (NPPO) must inspect the nursery stock to ensure it is free from visually detectable regulated pests, and it conforms to New ZealandÊs import requirements.

- Post-entry quarantine: the whole plants and cuttings must undergo Level 2 post-entry quarantine (PEQ) on arrival in New Zealand, during which time they undergo growing-season inspection by a MAF Biosecurity Inspector.

Plants in vitro, i.e. tissue culture: Assuming that aseptic lines of a tissue culture have been developed, and the tissue culture has been prepared for export under sterile conditions, plants *in vitro* have a very low likelihood of harbouring *P. psidii*. Under the current import health standard, the Basic Conditions for tissue culture (section 2.2.2) reduce some, but not all, of the risk of *P. psidii* entry and establishment. These conditions include:

- Pre-export phytosanitary inspection: prior to issuing a phytosanitary certificate, the exporting National Plant Protection Organisation (NPPO) must inspect the nursery stock to ensure it is free from visually detectable regulated pests, and it conforms to New ZealandÊs import requirements.

- Cleanliness and packaging: tissue culture must be packaged in pest proof and rigid containers, and must be free of visual contamination based on inspection on arrival by a Biosecurity Inspector

3.2 Pest Freedom

The International Standards for Phytosanitary Measures number 4: Requirements for the establishment of pest free areas, 1995 (ISPM No 4) describes the requirements for the establishment and use of pest free areas as a risk management option for meeting phytosanitary requirements for the import of plants. A pest free area (PFA) is defined under the International Plant Protection Convention as „an area in which a specific pest does not occur as demonstrated by scientific evidence and in which, where appropriate, this condition is being officially maintained‰ ISPM 4 identifies three main aspects that must be considered in the establishment and subsequent maintenance of a PFA:

- Systems to establish pest-free status
- Phytosanitary measures to maintain pest-free status
- Checks to verify pest-free status has been maintained.

When sufficient information is available to support a PFA declaration, this phytosanitary measure is usually considered to provide a very high level of protection. The PFA could be a country, or an area within a country that is free of *P. psidii* (based on official survey data), or an area not likely to have *P. psidii* introduced by natural dispersion, or does not have a climate that is likely to be suitable for *P. psidii* (e.g. arid parts of Australia are considered unsuitable for *P. psidii* (Booth & Javonivic, 2000)). MAF would need to assess the evidence for PFA in accordance with ISPM No. 4.

Two schedules (*Acca sellowiana* and *Eugenia*) allow import of whole plants and cuttings from approved countries only. In these cases the phytosanitary certificate must be endorsed with the additional declaration that „*Puccinia psidii* is not known to occur in (the country or

state of origin)‰This type of declaration is not the same as a Âpest-free place of productionÊ declaration, or a Âpest-free areaÊdeclaration certified by the exporting national plant protection organisation because it is not based on official pest surveys or inspections. Current approved countries include countries that have *P. psidii* e.g. Australia, USA.

The declaration only gives assurance that *P. psidii* is not known to occur. It is possible that it does occur, but has not yet been identified. This situation would have occurred for a period of time in Australia and Hawaii prior to *P. psidii* being identified and thus it would not be the only risk management measure in use.

3.3 Post Entry Quarantine

The Level 2 PEQ facilities minimise the risk of establishment of pests that are likely to be transmitted by wind, water, insects or other vectors. However, these conditions are considered inadequate to reduce the risk of *P. psidii* spore exposure to the environment to an acceptable level, because spores could escape Level 2 PEQ facilities. Windows and vents in Level 2 PEQ facilities are insect-proofed using mesh with a maximum aperture of 0.6 mm[1], but this will not prevent the escape of *P. psidii* spores (urediniospores are [a] 0.027 mm and teliospores are [a] 0.048 mm[2]) (Katan & Katan, 1997; Frinking *et al*., 1987; Pfender *et al.,* 2006; Chavarria *et al.,* 2009). The hygiene procedures in a Level 2 PEQ facility are not sufficient to stop transfer of spores onto personal clothing and subsequent movement outside the facility.

There are three major inadequacies of Level 2 PEQ for risk management of *P. psidii*:

- The mesh on vents is not capable of preventing escape fungal spores and so *P. psidii* spores could spread into the environment via exit through the vents (vent aperture is 0.6mm; urediniospore size is much smaller, 0.027 mm).
- The climate cannot be controlled, therefore the facility would not be able to ensure conditions are optimal for observing *P. psidii* contamination (see section below on quarantine period for further details).
- The operational procedures and record keeping are not sufficient to enable audits that would give assurances about the management of Level 2 PEQ.

Level 3 PEQ greenhouses have additional requirements for: record keeping; maintenance of operational procedures which relate to quality system requirements; an optional provision for spore-proof ventilation systems; climate control. All three of the Level 3 PEQ facilities in New Zealand are climate-controlled and under negative pressure. At least one is fitted with air filters that are effective against microbes (i.e. HEPA filtration). Level 3 PEQ would provide adequate risk management of *P. psidii*, assuming that spore-proof ventilation systems and adequate climate control are installed.

P. psidii can have a life cycle of 10-25 days. Therefore a weekly inspection or plant health check by PEQ operators, or representatives, is necessary to identify possible infections. Weekly plant inspections by the facility Operator is mandatory in Level 3 PEQ facilities and all records must be maintained by the operator or representatives. Therefore, only Level 3 PEQ provides an adequate plant inspection regime.

[1] See MAF Biosecurity Authority Standard PBC-NZ-TRA-PQCON Specification for the Registration of a Plant Quarantine or Containment Facility, and Operator; http://www.biosecurity.govt.nz/regs/trans/stds

[2] Refer to http://www.issg.org/database/species/ecology.asp?si=1538&fr=1&sts=&lang=EN and references therein.

If plants are grown at 15-23 ·C, high humidity, including overhead watering to promote leaf wetness, then disease caused by *P. psidii* can be expected to be visible after three to12 days, and probably within the three month PEQ period (summarised by Glen *et al.* 2007).

But under other conditions, urediniospores can remain viable beyond 3 months; Salustiano et al, 2008 reported urediniospores being viable for 150 days (about 5 months) (Salustiano *et al*, 2008; Suzuki & Silveira, 2003). Also, it is not known how long teliospores remain viable; teliospores are theoretically more persistent, but there is no data about teliospore survival time. Therefore, a quarantine period that extends beyond the maximum period of urediniospore viability is required. Six months is expected to be an adequate quarantine period.

Temperature and humidity conditions that will encourage *P. psidii* contaminations to become visible can currently only be guaranteed in Level 3 PEQ facilities with climate control (they are currently not available in any Level 2 PEQ facilities). If plants are housed under optimal conditions[3] for *P. psidii* development, spores would lose viability within six months (Suzuki & Silveira, 2003). Therefore the risk of *P. psidii* would be eliminated in PEQ, negating the need for mandatory testing.

For a six month PEQ period, there should be four growing-season inspections by the MAF Biosecurity Inspector (BSI). The first inspection would be expected to occur at four weeks, after the consignment enters the PEQ facility, and then at three weekly intervals until the final inspection at five and a half to six months, prior to release.

3.4 Additional conditions for Tissue Culture

Tissue cultures are seen as a lower risk pathway compared to whole plants and cuttings, however the current requirements for tissue culture in the IHS are not considered sufficient to manage the risk of contamination with *P. psidii* spores. No contamination of *P. psidii* in tissue culture have been reported, however it is conceivable that contamination could occur, as it is known for other rust fungi (Liefert & Cassells, 2001). *P. psidii* is not documented as having latent intracellular infections, and so it is expected that if a tissue culture plantlet was contaminated with *P. psidii*, symptoms would be visible within two to four weeks if the cultures are maintained at 15-23 ·C in high relative humidity (Glen *et al.* 2007).

Therefore it is proposed that tissue cultures spend at least four weeks in the container they are imported in (either prior to export or in post entry quarantine), and must be maintained between 15-23 ·C for this period. If this occurs prior to export, the exporting National Plant Protection Organisation (NPPO) must certify this on the phytosanitary certificate. Alternatively, the exporting NPPO can endorse an additional declaration on the phytosanitary certificate that „*Puccinia psidii* is not known to occur in the country of origin‰

4. PROPOSED AMENDMENTS TO THE STANDARD

It is proposed to rationalise the number of schedules for Myrtaceae species in the standard from five to three, by merging the *Acca sellowiana* (feijoa) and *Agonis* schedules with the *Metrosideros* schedule. The remaining three schedules would be:

- *Eucalyptus*

[3] Sub-optimal climate conditions may allow extended survival of spores.

- *Eugenia*
- *Metrosideros*

In addition, the Myrtaceae species currently eligible for import under Basic Conditions will be added to the *Metrosideros* schedule. The proposed amendments to these schedules are provided in the accompanying IHS document.

Updated Schedule	Genus	Approved exporting countries	Quarantine pests	Phytosanitary measures
Eucalyptus 263 species	• *Eucalyptus* (263)	All	*Puccinia psidii; Endothia havanensis; Mycosphaerella parva*	• Whole plants or cuttings: - Level 3 PEQ, 6 months. • Tissue culture: - Pre-export declarations OR - Level 2 PEQ, 4 weeks.
Eugenia 31 species	• *Eugenia* (22) • *Syzygium* (9)	Australia, Austria, Belgium, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Israel, Italy, Luxembourg, Norway, The Netherlands, Portugal, Spain, Sweden, Switzerland, United Kingdom.	*Puccinia psidii; Xylella fastidiosa*	• Whole plants or cuttings: - Level 2 PEQ for 6 months with Pest-free area declaration OR Level - Level 3 PEQ, 6 months. • Tissue cultures: - Pre-export declarations OR • Level 2 PEQ, 4 weeks.
Metrosideros 245 species	• *Acca sellowiana* Feijoa (1) • *Actinodium* (1) • *Agonis* (8) • *Angophora* (3) • *Astartea* (2) • *Austromyrtus* (1) • *Backhousia* (2) • *Baeckea* (10) • *Beaufortia* (3) • *Callistemon* (25) • *Calothamnus* (9) • *Calytrix* (9) • *Darwinia* (9) • *Hypocalymma* • *Kunzea* (15) • *Leptospermum* (44) • *Lophomyrtus* (3) • *Lophostemon* (1) • *Luma* (1)	Australia, Austria, Belgium, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Israel, Italy, Luxembourg, Norway, The Netherlands, Portugal, Spain, Sweden, Switzerland, United Kingdom, USA	*Puccinia psidii*	• Whole plants or cuttings: - Level 2 PEQ for 6 months with Pest-free area declaration OR Level - Level 3 PEQ, 6 months. • Tissue cultures: - Pre-export declarations OR • Level 2 PEQ, 4 weeks.

	• *Melaleuca* (48) • *Metrosideros* (19) • *Micromyrtus* (1) • *Myrciaria* (2) • *Myrtus* (6) • *Pimenta* (1) • *Psidium* (7) • *Thryptomene* (8) • *Verticordia* (4)			

REFERENCES

Alfenas, A.C., Maffia, L.A., Macabeu, A.J. and Sartorio, R.C. 1993. Efficiency of triadimenol, oxycarboxin and diniconazole for rust (*Puccinia psidii*) control in coppice of *Eucalyptus cloeziana* under field conditions. *Revista Arvore* 17(2): 247-263.

Carnegie, A.J., Lidbetter, J R., Walker, J., Horwood, M.A., Tesoriero, L., Glen, M., and Priest, M.J. 2010. *Uredo rangelii*, a taxon in the guava rust complex, newly recorded on Myrtaceae in Australia. *Australasian Plant Pathology* 39(5): 463-466.

Chavarria, G., Santos, H.P., Fin, E., Sonego, O.R., Garrido, L.R. and Marodin, G.A.B. 2009. Aerial dispersion of *Plasmopara viticola* spores in covered and conventional cultivation of grapevine. *Revista Brasileira de Fruticultura* 31(3): 710-717.

Ferrari, J.T., Nogueira, E.M. de C. and Santos, A.J.T. 1997.Control of rust (*Puccinia psidii*) in guava (*Psidium guajava*). *Acta Horticulturae* (452): 55-57.

Frinking, H.D., Gorissen, A. and Verheul, M.J. 1987. Dissemination of spores in a glasshouse: pattern or chaos? *International journal of biometeorology* 31(2): 147-156.

Glen, M., Alfenas, A,C., Zauza, E.A.V., Wingfield, M.J. and Mohammed, C. 2007. Puccinia psidii: a threat to the Australian environment and economy· a review. *Australasian Plant Pathology* 36(1): 1-16.

Govaerts, R. and Lucas, E. 2008. *World Checklist of Myrtaceae.* Royal Botanic Gardens Kew.

Katan, T., Shlevin, E. and Katan, J. 1997. Sporulation of *Fusarium oxysporum* f.sp. *lycopersici* on stem surfaces of tomato plants and aerial dissemination of inoculum. *Phytopathology* 87(7): 712-719.

Kawanishi, T., Uematsu, S., Kakishima, M., Kagiwada, S., Hamamoto, H., Horie, H. and Namba, S. 2009. First report of rust disease on ohia and the causal fungus, *Puccinia psidii*, in Japan. *Journal of General Plant Pathology* 75(6): 428-431.

Killgore, E.M., Heu, R.A. (updated March 2007) *Ohia rust. Puccinia psidii Winter:* Hawaii Department of Agriculture.

Liefert, C. and Cassells, A.C. 2001. Microbial hazards in plant tissue and cell cultures. *In Vitro Cellular & Developmental Biology*. Plant 37: 133-138.

Loope, L. and La Rosa, A.M. 2008. An Analysis of the Risk of Introduction of Additional Strains of the Rust *Puccinia psidii* Winter (Ohia Rust) to Hawaii. U.S Geological Survey Open-File Report 2008 -1008.

Maclachlan, J. D. 1936. The pimento rust disease. *Journal of the Jamaica Agricultural Society* 40: 277-281.

MAF. 2009. Update of Tissue Culture Import Requirements. An internal MAF report. Ministry of Agriculture and Fisheries, New Zealand.

MAF. 2010. A Review of Australia's Myrtle Rust Response 2010. A report for MAF Biosecurity New Zealand.

MAF. 2011. Risk analysis of the Guava Rust complex (including *Uredo rangelii* and *Puccinia psidii*) on nursery stock. A report for MAF Biosecurity New Zealand.

NSW Department of Primary Industries (2011) Situation Update 2 February 2011. *http://www.dpi.nsw.gov.au/biosecurity/plant/myrtle-rust/update*

Pfender, W., Graw, R., Bradley, W., Carney, M. and Maxwell, L. 2006. Use of a complex air pollution model to estimate dispersal and deposition of grass stem rust urediniospores at landscape scale. *Agricultural and Forest Meteorology* 139(1/2): 138-153.

Ruiz, R.A.R., Alfenas, A.C., Ferreira, F.A. and Zambolim, L. 1987. Protective and systemic fungicides for the control of eucalypt rust caused by *Puccinia psidii*. *Revista Arvore* 11(1): 56-65.

Ruiz, R.A.R., Alfenas, A.C. and Demuner, N.L. 1991. Efficiency of fungicides for the control of rust (*Puccinia psidii*) on guava (*Psidium guajava*). *Summa Phytopathologica* 17(2): 147-153.

Suzuki, M.S. and Silveira, S.F. 2003. *In vitro* germination of *Puccinia psidii* urediniospores stored under different combinations of relative humidity and temperature. *Summa Phytopathologica* 29(2): 188-192.

Wang, W. 1992. Survey of Eucalyptus diseases in Taiwan. *Bulletin of the Taiwan Forestry Research Institute* 7(2): 179-194.

Wilson, P.G., OÊBrien, M.M., Gadek, P.A. and Quinn, C.J. 2001. Myrtaceae revisited: A reassessment of Infrafamilial Groups. *American Journal of Botany* 88: 2013-2025.

Appendix 1: Myrtaceous genera with species susceptible to *Puccinia psidii*

Prior to the Australian incursion, the known number of genera with species susceptible to *P. psidii* was 21; they are printed below in black italics with no highlighting.

As at 2 February 2011, the 14 genera that are highlighted with yellow were new to the host list since the detection of *U. rangelii* in Australia in April 2010, bringing the total to 35. As at 13 June 2011, 10 additional genera (highlighted in green) were new to the host list since 2 February 2011, bringing the total to 45 genera. This represents a 114% increase of new host genera.

Acca (synonym *Feijoa*)
Acmena
Acmenosperma
Agonis
Anetholea
Astereomyrtus
Austromyrtus
Angophora
Backhousia
Callistemon
Calothamnus
Campomanesia
Chamelaucium
Choricarpia
Corymbia
Decaspermum
Eucalyptus
Eugenia
Gossia
Heteropyxis
Kunzea
Lenwebbia
Leptospermum
Lophomyrtus
Marlierea
Melaleuca
Metrosideros
Myrcia
Myrcianthes
Myrciaria
Myrtus
Pilidiostigma
Pimenta
Psidium
Rhodamnia
Rhodomyrtus
Ristantia
Stockwellia
Syncarpia
Syzygium
Tristania
Ugni
Uromyrtus
Waterhousea
Xanthostemon