Guide to the removal and fungicide treatment of myrtle rust

Information for plant nurseries, council-controlled areas and home gardens

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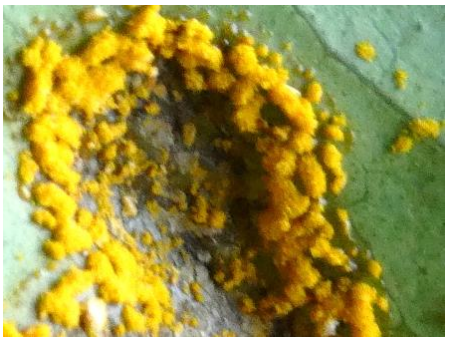
Myrtle rust in Aotearoa New Zealand

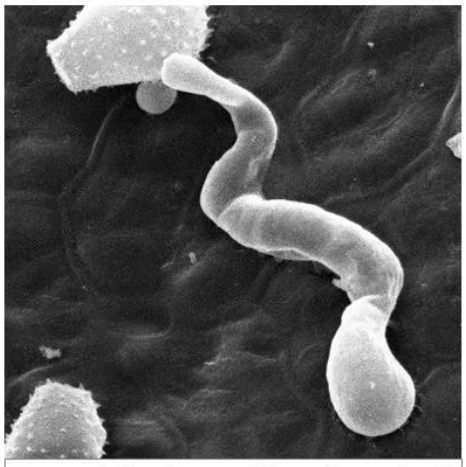
- Myrtle rust is caused by the fungal pathogen *Austropuccinia psidii*. It was first found in Aotearoa New Zealand in 2017 and is now widespread throughout Te Ika-a-Māui North Island and the upper part of Waipounamu South Island. It has also been found as far south as Canterbury and the West Coast.
- It is still spreading; increasing in severity and affecting more species each year.

  Only plants in the myrtle family (Myrtaceae) are affected. For all host species recorded in NZ see: https://www.myrtlerust.org.nz/about-myrtle-rust/species-infected-with-myrtle-rust-in-new-zealand/
- The most severely impacted native and exotic species are listed in Appendix 1.
- Only young, actively growing leaves, stems, flowers and fruit can become infected.
- Myrtle rust risk is greatest in summer and in warmer northern areas, as shown in Appendix 1.

Myrtle rust infection



- The yellow spores are spread by wind from pustules on infected plants.
- They infect healthy plants when there is wetness or high humidity for more than 6 hours and temperature is above 10-12°C.
- Infection occurs with overnight dew but light rain or overhead irrigation also provide suitable conditions.
- Myrtle rust spores are short lived; they either infect during wetness or they die. They survive at most a few days on non-host plant surfaces, including in the soil.



Spore infecting a pōhutukawa leaf
Photo: Ian Hallett

How to remove and dispose of infected material

- If you think you have plants infected by myrtle rust, first be sure it actually is myrtle rust – know your myrtle hosts and what myrtle rust symptoms look like. See the following:

  Key to the Myrtaceae of New Zealand » Manaaki Whenua (landcareresearch.co.nz)

  How to recognise myrtle rust » Myrtle Rust
- Plant-species-confirmed-to-be-infected-with-myrtle-rust-in-New-Zealand4.pdf (myrtlerust.org.nz)
- Also, report your find on iNaturalist (Myrtle Rust Reporter · iNaturalist)
- **When yellow spore pustules are found, don't delay** – remove infected plant parts as soon as possible with minimum disturbance to avoid spreading the spores.
- Place infected material into plastic bags and leave them sealed for three weeks or until the plant material (and the myrtle rust) have died.
- If infection is too extensive to remove from individual plants, then carefully remove and dispose of all infected plants by burying, bagging for three weeks or bagging and sending to landfill.
- Old myrtle rust infection (blotches, dead patches on leaves, shrivelled leaves and dead stems) presents a lower risk, but should still be removed and disposed of as described above.

- Further information:
  Myrtle rust: Biosecurity threats (doc.govt.nz)

  How-to-remove-infected-myrtle-plants-and-safely-dispose-of-the-waste.pdf (myrtlerust.org.nz). Note that some of the information at this particular website is out of date.

Use of fungicide sprays

- Spray all infected plants but only after infection has been removed and, where possible, also spray other vulnerable myrtles in the vicinity. Appendix 1 shows which species need fungicide protection.
- To start with, use one of the 'highly effective' fungicides listed in Table 1 below. After that, vary the fungicides used according to the resistance prevention guideline provided below.
- For plant nurseries, year round preventative spray programmes are required on highly vulnerable species. New Zealand Plant Producers Inc. (NZPPI) has produced a list of fungicides available in New Zealand that are suitable for controlling myrtle rust. (Download.aspx (nzppi.co.nz))
- Appendix 2 shows examples of annual spray programmes for the most vulnerable species in high and low risk climatic areas of New Zealand. This is further explained in the Plant & Food Research report for Ministry for Primary Industries (MPI) on Risk-based fungicide management for myrtle rust in nurseries (mpi.govt.nz)
- A weather-risk tool to with timing fungicide sprays according to seasonal weather risk is available care of NZPPI at NZPPI Plant Disease Management Platform (metwatch.nz)
- See the glossary of terms relating to fungicides on page 7.

Regulations on fungicide use

- No fungicides are registered specifically for myrtle rust in New Zealand, but ones registered for other uses can be applied under 'off-label use': Guidelines (nzgap.co.nz).
- The application rate for any fungicide product should be chosen from the label rate for an appropriate equivalent crop: Ministry for Primary Industries - ACVM Register (nzfsa.govt.nz).
- A **Growsafe Approved Handler Certificate** is generally required when purchasing and applying fungicides. Growsafe information: Home (growsafe.co.nz).
- Anyone can buy fungicides from garden supply shops without an Approved Handler Certificate, but **Growsafe Basic** training is still recommended.
- The garden supply shop products shown here contain active ingredients that are effective against myrtle rust.

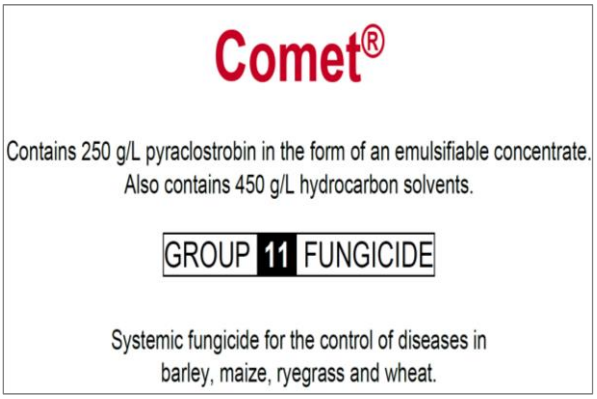
- Most fungicides potentially affect human health and the environment. For the hazard classification system for fungicides see Risks of Agrichemicals (growsafe.co.nz). To find out about the hazards for individual products, search online for the safety data sheet (SDS) under the fungicide product name.

Avoiding fungicide resistance

What is fungicide resistance?

- Nurseries in high-risk northern areas (Appendix 2) could require as many as 20–30 fungicide sprays per year to control myrtle rust on vulnerable hosts. Such high use poses a risk from fungicide resistance developing in *A. psidii* to certain fungicides and this risk needs to be managed.
- Resistance develops when repeated use of a particular fungicide selects a part of the pathogen population that has a natural genetic mutation allowing increased survival in the presence of the fungicide. Continued exposure to the fungicide may cause the resistant part of the population to predominate and the fungicide may eventually no longer control the disease.
- Fungicides at risk from resistance are modern synthetic ones where the mode of action inhibits a specific biochemical pathway vital to the pathogen's metabolism (single-site inhibitors). Older fungicides, which have a more general poisoning effect on the pathogen, are known as multi-site inhibitors or broad spectrum fungicides and are generally not at risk from resistance.
- Resistance development can be delayed by avoiding repeated use of at-risk fungicides. Those that are at risk can be identified by the mode of action (MOA) group number that appears on product labels.

- Example mode of action (MOA) group numbers on a Group 3 (DMI) product and a Group 11 (QoI) product. (See the list of myrtle rust fungicides in Table 1 below.)



Fungicide resistance prevention guideline for myrtle rust

- Fungicides in mode of action groups 3 DMI, 7 SDHI and 11 QoI (Table 1) are suitable for controlling myrtle rust but are at risk from resistance. These should be used as follows:

    1. Apply preventatively when disease risk is high and preferably before disease appears.
    2. Make no more than five applications of each at-risk group per year (1 July – 30 June).
    3. Apply each at-risk fungicide either in mixture with an effective dose of a multi-site inhibitor (groups M1, M3 and M5) or in strict alternation with either a single-site fungicide in a different group or, preferably, a multi-site fungicide.
    4. When choosing fungicides, make use of the group codes displayed on product labels to avoid mixed or consecutive applications of the same at-risk mode of action group.
    5. The application rate of a fungicide used for myrtle rust control should be the recommended label rate for that fungicide on an appropriate other crop (Ministry for Primary Industries - ACVM Register (nzfsa.govt.nz)).
    6. An application of a product containing a mixture of two fungicides in the same mode of action group counts as one application towards that group's annual count.

- The Environmental Protection Authority (EPA) may specify a maximum number of applications per year for particular fungicide products. This takes priority over maximum numbers indicated in this resistance management guideline for any so-specified product (e.g., only one application of Elatus® Plus per year is allowed). (Controls for hazardous substances | EPA).

Alternative fungicidal chemicals

- Some people concerned about the toxicity of conventional fungicides are trying benign chemicals, like baking soda, for myrtle rust control. Baking soda can give suppression of some plant diseases but it's efficacy against myrtle rust has not been tested. It is expected to have low efficacy.
- Other alternative chemicals are yet to be tested against myrtle rust.

Table 1. Myrtle rust fungicide mode of action groups[1]. (See NZPPI (Download.aspx (nzppi.co.nz))

Example product names	*Active ingredient name*	*[2]Group code*	*Mode of action*
Highly effective			
Group 3 DMI			***Single-site inhibitor***
Cereous®, Vandia®, etc Tilt®, Spotless, etc Opus®, Stellar, etc Radial® Scorpio Several others	Triadimenol Propiconazole Epoxiconazole Epoxiconazole+ azoxystrobin Tebuconazole+ trifloxystrobin	3	DMI (Demethylation inhibitor) *Systemic with good curative and variable protectant activity*
Group 11 QoI			***Single-site inhibitor***
Amistar® Comet Flint®, Protiva® Scorpio Several others	Azoxystrobin Pyraclostrobin Trifloxystrobin Trifloxystrobin+ tebuconazole	11	QoI (Quinone outside inhibitor) *Systemic with protectant and curative activity*
Slightly effective			
Group 7 SDHI			***Single-site inhibitor***
[3]Sercadis® Elatus® Plus Several others	Fluxapyroxad Benzovindiflupyr	7	SDHI[3] (Succinate dehydrogenase inhibitor) *Protectant and slightly systemic activity*
Groups M1, M3, M5			***Multi-site inhibitor (broad spectrum fungicides)***
Kocide® Opti™, etc. Dithane®, Mancozeb, etc. Bravo® , etc.	Copper hydroxide, etc. Mancozeb Chlorothalonil	M1 M3 M5	Copper Dithiocarbamate Chloronitrile *Protectant activity only*

[1]Also see fungicide information from New Zealand Plant Producers Inc. Download.aspx (nzppi.co.nz)).

[2]Fungicide Resistance Action Committee, Europe (frac-code-list-2022--final.pdf). Use this link together with Ministry for Primary Industries - ACVM Register (nzfsa.govt.nz) to discover all NZ products in these groups. Note that some products may be seed treatments or pruning wound treatments.

[3]Sercadis has shown limited efficacy against myrtle rust in NZ field trials; Elatus Plus needs testing.

Table 2. Efficacy of myrtle rust fungicides available in New Zealand

The table below is compiled from the NZPPI list of fungicides and field trial information on fungicide control of myrtle rust (*Austropuccinia psidii*) published internationally, as summarised by Chng et al (2019) and from experience from recent New Zealand field trials (Beresford & Wright 2022).

Below the table are comments about fungicide mixtures and a glossary of terms relevant to myrtle rust fungicides, their modes of action, efficacy and the development of fungicide resistance.

Fungicide active ingredient	Mode of action group	[1]Relative myrtle rust efficacy	Comments
Multi-site inhibitors			
Copper hydroxide	M1	+	Variable performance reported but generally poor
Copper oxide	"	+	"
Copper oxychloride	"	+	"
Mancozeb	M3	+	"
Chlorothalonil	M5	+	"
Single-site inhibitors	(Good curative activity, variable protectant activity)		
Cyproconazole	Group 3 DMI	++	Only reported use is in mixture with Group 11 fungicides
Epoxiconazole	"	++	Only reported use is in mixture with Group 11 fungicides
Myclobutanil	"	++	Good curative but limited protectant activity
Propiconazole	"	++	
Tebuconazole	"	++	
Triadimenol	"	+++	Consistently reported as having best myrtle rust efficacy
Triforine	"	++	Variable performance reported
Benzodiflupyr	Group 7 SDHI	+	Uncertain efficacy; further testing of this Group 7 required
Fluxapyroxad	"	+	"
Azoxystrobin	Group 11 QoI	++	Good protectant activity and curative activity
Pyraclostrobin	"	++	"
Trifloxystrobiin	"	++	"
Mixtures containing a Group 3 and a Group 11 fungicide		+++	
Other mixtures		++	

[1] Efficacy from field trial data in NZ or overseas: + = slight; ++ = Moderate; +++ = High
Efficacy inferred from reports on other members of the same MOA group: + = Slight; ++ = Moderate; +++ = High

Fungicide mixtures

- Mixtures of fungicides are often used, either pre-mixed by manufacturers or tank mixed by fungicide handlers, which usually consist of two active ingredients.
- When using fungicide mixtures it is important to understand the efficacy of each component.
- A mixture of an efficacious fungicide with a compound or agent having little or no efficacy is undesirable because it may not be possible to tell which component is effective.
- Mixtures of two fungicides, each at an effective dose, would be expected to have an additive effect. However, it is sometimes claimed that particular mixtures have a synergistic effect (greater than the combined individual effects), but this is actually difficult to substantiate.
- When fungicide mixtures are used for resistance prevention, each component must have efficacy against myrtle rust and be applied at an effective dose.

Glossary of fungicide terms

Active ingredient (active constituent). The component(s) in a formulated fungicide product that specifically inhibit the target pathogen. Products also contain other chemicals to achieve effective delivery of the active ingredient to the plant. The active ingredient name is the common name of the fungicide (e.g., triadimenol).

Control: Demonstrable prevention or inhibition of myrtle rust development.

Curative (systemic). A fungicide active ingredient that is absorbed into the plant and inhibits the pathogen within the plant tissues after infection has occurred. Such fungicides generally have a limited time after infection to 'cure' the infection (e.g. 1-3 days). This is often referred to as the 'reach-back' or 'kick-back' interval or period. 'Systemic' means within the plant tissue and is often used synonymously with 'curative'. Curatives may also be effective protectants.

Efficacy: The intrinsic ability of a fungicide to prevent infection or inhibit *A. psidii,* and thereby control myrtle rust, determined under controlled conditions.

Effectiveness: The myrtle rust control outcome from using fungicide(s) in the real world where factors in addition to efficacy affect control, e.g. application rate and mixing with other agents.

Effective dose: The amount of a fungicide with efficacy against myrtle rust that must be applied to plants to achieve myrtle rust control.

Eradicant. A fungicide that kills existing fungal lesions on the plant. Eradicant is sometimes used synonymously with curative, but eradicants are not necessarily absorbed into the plant. Eradicants are often older multi-site inhibitor fungicides.

Mode of action (MOA). The biochemical pathway(s) within fungal cells inhibited by a particular fungicide. The Fungicide Resistance Action Committee (FRAC) in Europe assigns a code number to each MOA Group (frac-code-list-2022--final.pdf). The product label displays all the active ingredient groups in the product and the group code numbers. When fungicide resistance develops in a pathogen to a particular fungicide, then all the active ingredients within the same MOA group are expected to be affected by that resistance. However, in practice different active ingredients within a group are often affected by resistance slightly differently.

Mode of action Group 3 (demethylation inhibitor; DMI). Single-site inhibitors with a mode of action that blocks the demethylation step in sterol biosynthesis necessary for chitin cell wall formation in fungi. These are also referred to as azole or triazole fungicides, based on their chemistry.

Mode of action Group 7 (Succinate dehydrogenase inhibitor; SDHI) Single-site inhibitors with a mode of action that blocks mitochondrial respiration in fungal cells by inhibiting the succinate dehydrogenase enzyme that catalyses the oxidation of succinate into fumarate in the Krebs cycle.

Mode of action Group 11 (Quinone outside inhibitor QoI; strobilurin). Single-site inhibitors with a mode of action that blocks mitochondrial respiration in fungal cells at the quinone outside binding site of the cytochrome bc_1 complex.

Multi-site inhibitors (Groups M1, M3 and M4) Older fungicides that inhibit many metabolic pathways in the target pathogen (also known as broad spectrum fungicides). These are generally not at risk from resistance development in the pathogen.

Protectant. A fungicide that is only active against the pathogen on the plant surface where it prevents infection.

Single-site inhibitors. Modern synthetic fungicides that inhibit a specific metabolic pathway in the target pathogen. These are often at risk from development of fungicide resistance in the pathogen.

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HORTPLUS
Grow Smarter with the Right Data

References

Beresford RM, Wright PJ July 2022. Risk-based fungicide management for myrtle rust in nurseries. A Plant & Food Research report prepared for: Ministry for Primary Industries. PFR SPTS No. 22715 (in review).

Chng S, Soewarto J, Adusei-Fosu K, Rolando C, Ganley R, Padamsee M, Waipara N, Grant A, Wegner S, Gee M 2019. Potential disease control tools most likely to be effective against *Austropuccinia psidii*. Report prepared for the Ministry for Primary Industries July 2019. Biosecurity New Zealand Technical Paper No: 2019/27.

Appendix 1 – Myrtles requiring fungicide protection & myrtle rust climatic risk

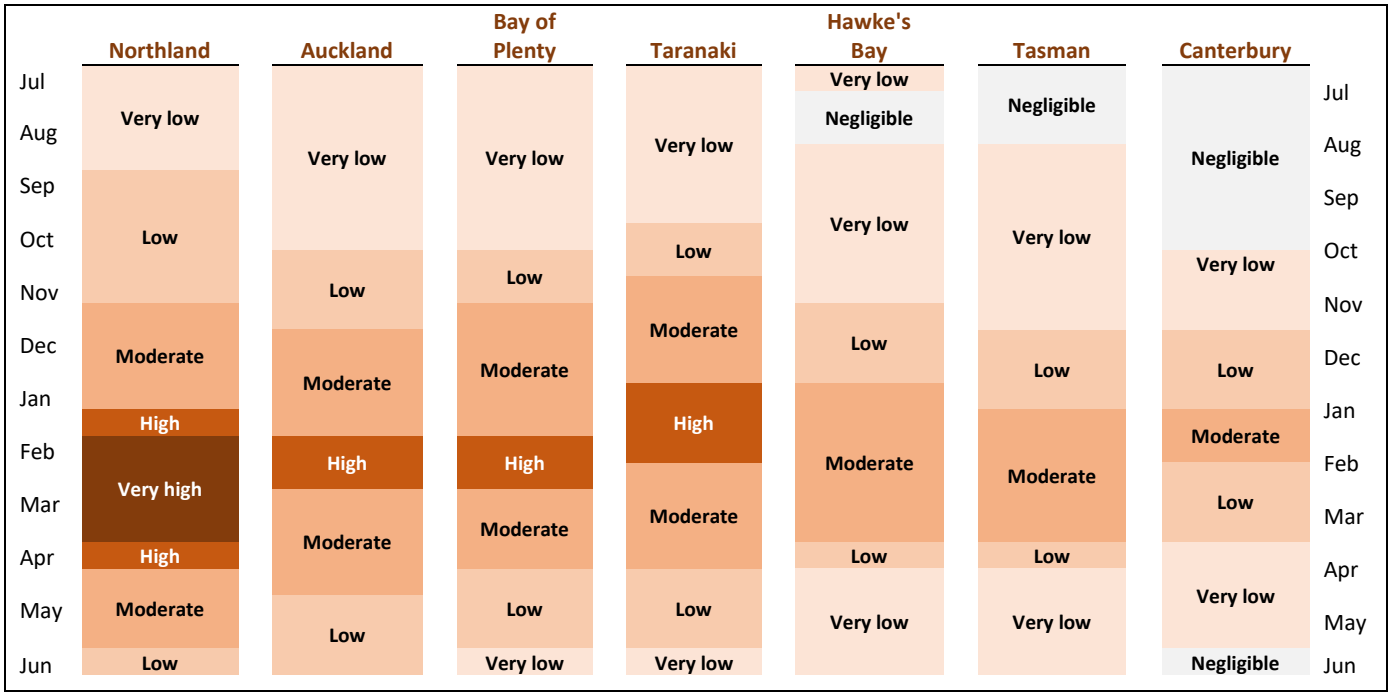
Note that our knowledge about myrtle rust impacts on different myrtle species is evolving over time.

Common name	Botanical name	All plants need constant protection[1]	Young seedlings need constant protection[1]	Only spray during periods of high or very high risk[1]	Fungicides are not necessary unless myrtle rust is found
Native species					
[2]Maire tawake; swamp maire	*Syzygium maire*	✓			
[2]Ramarama	*Lophomytus bullata*	✓			
[2]Rōhutu	*Lophomytus obcordata*	✓			
Pōhutukawa	*Metrosideros excelsa*		✓		
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 seedlings may be infected)			✓
Kānuka	*Kunzea robusta*				✓
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				✓

[1] See the climatic risk chart below. Spray intervals range from once every 7-14 days (depending on product efficacy) when risk is high or very high to once every 1-2 months when risk is very low. Spraying is not necessary when risk is negligible.

[2]These three species are the most vulnerable and are severely attacked as both seedlings and mature plants

Climatic risk by season and region (Also see Myrtle Rust Risk Prediction | Weekly Risk Maps)



Appendix 2 – Example myrtle rust spray programmes for highly vulnerable species (e.g., *Lophomyrtus*) in a high risk area (Northland) and a low risk area (Canterbury)

Kerikeri, Northland (Infection sources risk = High)

Month	Climatic risk	Spray no.	Fungicide Spray date	Interval to next spray (days)	Fungicide mode of action group (see Table 1)
July	Very low	1	1-Jul-22	21	M1 copper
		2	22-Jul-22	21	M1 copper
August		3	12-Aug-22	21	M1 copper
September	Low	4	2-Sep-22	14	M1 copper
		5	16-Sep-22	21	11 QoI
October		6	7-Oct-22	14	M3 mancozeb
		7	21-Oct-22	21	3 DMI
November		8	11-Nov-22	14	M3 mancozeb
	Moderate	9	25-Nov-22	14	7 SDHI
December		10	9-Dec-22	14	3 DMI + M3 mancozeb
		11	23-Dec-22	14	11 QoI
January		12	6-Jan-23	10	M3 mancozeb
		13	16-Jan-23	14	3 DMI + 11 QoI
	High	14	30-Jan-23	7	M3 mancozeb
February	Very high	15	6-Feb-23	7	7 SDHI
		16	13-Feb-23	7	11 QoI
		17	20-Feb-23	7	M3 mancozeb
		18	27-Feb-23	14	3 DMI + 11 QoI
March		19	13-Mar-23	14	7 SDHI + mancozeb
		20	27-Mar-23	14	3 DMI + M3 mancozeb
April	High	21	10-Apr-23	14	M3 mancozeb
	Moderate	22	24-Apr-23	7	M3 mancozeb
May		23	1-May-23	14	7 SDHI +M3 mancozeb
		24	15-May-23	10	M3 mancozeb
		25	25-May-23	14	7 SDHI
June	Low	26	8-Jun-23	14	M1 copper
		27	22-Jun-23	14	M1 copper

Lincoln, Canterbury (Infection sources risk = Low)

Month	Climatic risk	Spray no.	Fungicide Spray date	Interval to next spray (days)	Fungicide mode of action group (see Table 1)
July	Negligible				
August					
September					
October					
	Very low	1	15-Oct-21	28	M1 copper
November		2	12-Nov-21	28	M1 copper
December	Low	3	10-Dec-21	28	11 QoI
		4	31-Dec-21	21	7 SDHI
January	Moderate	5	21-Jan-22	21	3 DMI
February		6	4-Feb-22	14	M3 mancozeb
March	Low	7	4-Mar-22	28	11 QoI
April	Very low	8	1-Apr-22	28	3 DMI
		9	29-Apr-22	28	7 SDHI
May		10	27-May-22	28	M3 mancozeb
June	Negligible				

Fungicide spray programme summary

Kerikeri, Northland		Lincoln, Canterbury	
Sprayer passes	**27**	**Sprayer passes**	**10**
Product applications	**33**	**Product applications**	**10**
DMIs	**5**	**DMIs**	**2**
QoIs	**5**	**QoIs**	**2**
SDHIs	**5**	**SDHIs**	**2**
Multi-site	**18**	**Multi-site**	**4**