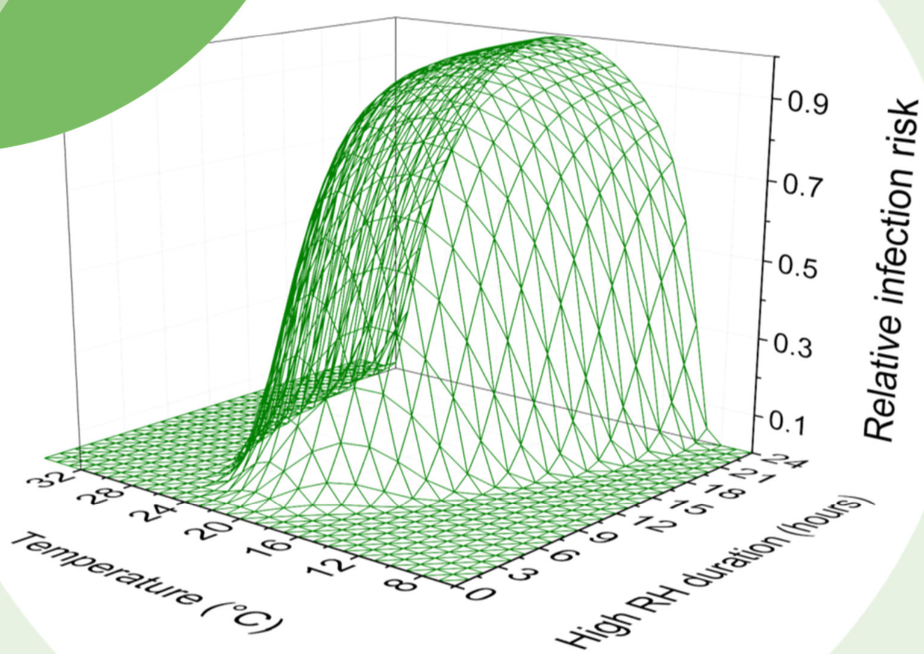

PFR SPTS No. 23921

NZPPI myrtle rust weather risk tool validation and update

Beresford RM

May 2023

Confidential report for:

New Zealand Plant Producers Inc. and HortPlus Limited

PUBLICATION DATA

Beresford RM. May 2023. NZPPI myrtle rust weather risk tool validation and update. A Plant & Food Research report prepared for: New Zealand Plant Producers Inc. and HortPlus Limited. Milestone No. 97895. Contract No. 41360. Job code: P/391008/01. PFR SPTS No. 23921.

KEYWORDS: Climatic risk modelling, disease management, decision support, fungicide efficacy, mode of action groups.

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Executive summary

NZPPI myrtle rust weather risk tool validation and update

Beresford RM
Plant & Food Research Auckland

May 2023

HortPlus Ltd is currently upgrading the myrtle rust risk-weather risk tool for New Zealand Plant Producers Inc. (NZPPI) with technical guidance from Plant & Food Research. The upgrade introduces the risk accumulation model to allow nursery managers to determine the optimum timing of fungicide applications to prevent myrtle rust establishing in nurseries.

This report updates previous information provided to HortPlus Ltd in September 2022 on the accumulating risk algorithm and calculation of spray re-application intervals for fungicides with differing efficacy. It follows validation of the risk accumulation model during the myrtle rust season of 2022–23.

The weather risk indicator used in the upgrade is the accumulated daily overall risk determined from the existing daily infection risk multiplied by 1/latent period, where latent period is the time from infection to new spores (generation time of the pathogen). Overall Risk reflects both weather suitable for infection and rate of disease development. Intense rainfall can remove the fungicide deposit from foliage and is factored into the model by the following rule: Fungicide re-application is required if there is 25 mm or more rainfall in any one day or 50 mm or more over three consecutive days.

Fungicide products differ in their efficacy against myrtle rust depending on the active ingredient(s) they contain and this affects the required fungicide re-application interval. The fungicide efficacy information previously provided to HortPlus in September 2022 has been reviewed in the light of new field trial data and this report updates the fungicide re-application interval algorithm. This includes a new efficacy category of ‘alternative fungicides’.

Recommendations are made for an update of the ‘Interpret Risk’ information in the weather risk tool in line with the updated algorithm and risk display.

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1 Introduction

The Myrtle Rust Process Model (MRPM) for assessing myrtle rust climatic risk (Beresford et al 2018) has been customised by Plant & Food Research and HortPlus Ltd for New Zealand Plant Producers Inc. (NZPPI) as a weather-risk tool to help nursery managers optimise fungicide spraying for myrtle rust control. Spraying for myrtle rust in vulnerable myrtle species requires more or less constant fungicide protective cover during a year. The tool uses a new approach to assess seasonal changes in disease risk and the need for fungicide cover by using an accumulation of risk coupled with efficacy characteristics of fungicide products to determine how often sprays should be applied.

This report covers Milestone 3, validation of fungicide spray interval functionality (Table 1), of four work areas carried out by Plant & Food Research (PFR) for NZPPI during 2022–23. It updates the risk algorithm and fungicide efficacy assumptions following field evaluations of the tool during 2022–23.

Table 1. Contracted work undertaken by Plant & Food Research for New Zealand Plant Producers Incorporated between July 2022 and May 2023.

Milestone	Description
1	Development of myrtle rust management information to national nursery workshops delivered in conjunction with NZPPI.
2	Development of a fungicide resistance prevention/management guideline approved by the NZ Committee on Pesticide Resistance (NZCPR) and placed on NZ Plant Protection (NZPPS) website.
3	Validation of the weather risk tool fungicide spray interval functionality developed and implemented with HortPlus in October/November 2022.
4	Development of non-chemical myrtle rust control management recommendations compiled from various information sources.

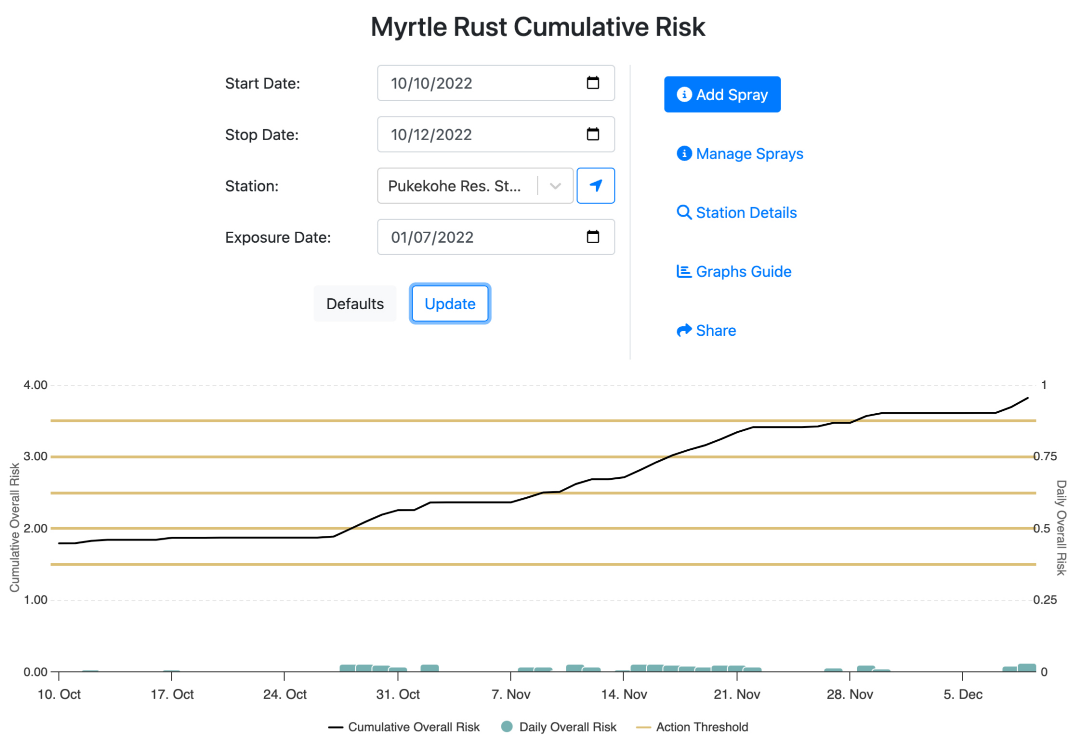
2 Cumulative weather risk

Accumulated daily overall risk is the indicator that determines how myrtle rust risk is developing during a whole season or user-defined period (Figure 1). Overall risk is calculated from daily infection risk multiplied by 1/latent period, where latent period is the time from infection to new spores (Beresford et al. 2020). Overall risk therefore reflects both weather suitable for infection and rate of disease development.

The risk predictions apply to highly vulnerable myrtle plants, e.g. *Lophomyrtus* sp. and pōhutukawa seedlings that are grown in areas where infection is likely.

Heavy rainfall can wash the protective fungicide deposit off plant foliage so that it needs to be re-applied. This upgrade uses the same rule-of-thumb as previously implemented to predict rain wash-off of fungicide, as follows:

- During the calculated re-application interval after a fungicide is applied, re-application is required if there is 25 mm or more rainfall in any one day or 50 mm or more over three consecutive days.



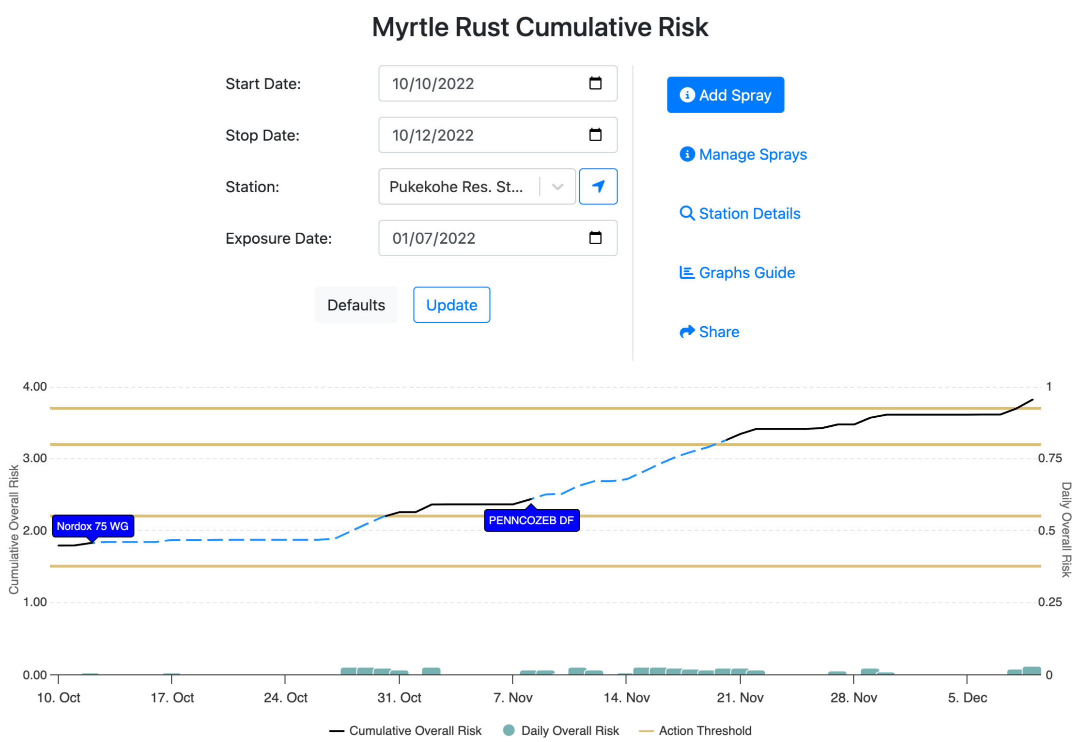


Figure 1. Risk display of cumulative daily overall risk for the weather station at Pukekohe Research Station from 10 October to 10 December 2022. The upper graph shows the solid black line of accumulating overall risk without fungicide applications and the lower graph shows the blue dashed line for periods when fungicide protection is present as a result of Nordox and Penncozeb® applications.

3 Fungicide mode-of-action groups

No fungicide products are registered specifically for controlling myrtle rust in New Zealand, but ones registered for other uses can be applied under 'off-label use': Guidelines (nzgap.co.nz). Fungicide application rates should be based on label claims for appropriate other crops.

Fungicide products contain one or more active ingredients (AIs) and each AI belongs to a mode of action (MOA) group. AIs within a MOA group differ in their chemistry but all inhibit target fungal pathogens by a biochemical mechanism common to that group. The MOA groups effective against myrtle rust are: 3 (demethylation inhibitors), 7 (succinate dehydrogenase inhibitors), 11 quinone outside inhibitors, M1 (copper compounds), M3 (dithiocarbamates), and M5 (chloronitriles) (frac-code-list-2022--final.pdf). NZPPI have compiled a list of products it recommends for myrtle rust management (Appendix 1.)

Within the above MOA groups are more than 30 AIs registered in New Zealand by the Agricultural and Veterinary Medicines (ACVM) Group of the Ministry for Primary Industries. There may be as many as 100 fungicide products on the market within those groups. Efficacy data are only available for a small fraction of these and therefore, for the weather-risk tool, assumptions need to be made about product efficacy based on the general efficacy characteristics of each MOA group (Appendix 2).

Some alternative 'fungicides', which contain relatively benign chemicals (e.g. Timorex Gold® tea tree oil extract and baking soda sodium bicarbonate) have been tested against myrtle rust (Adusei-Fosu et al. 2019, Beresford unpublished). These may have limited efficacy in some low disease risk situations but are not effective when disease risk is moderate or high.

There is variation in efficacy against myrtle rust between MOA groups and there may be variation between AIs within a group. The weather risk tool assumes AIs within each MOA group perform similarly, within the limitations and appropriateness of particular fungicide products. Efficacy information is available from testing done overseas (Chng et al 2019) and in New Zealand (Beresford et al. 2022), however, some of the information in Appendix 1 may not be accurate and further testing is required. **It is recommended for HortPlus to include a prominently displayed disclaimer about the fungicide product recommendations and fungicide timing indicated in the weather risk tool.**

4 Fungicide efficacy categories

For this update, the re-application interval is now calculated from nine categories of relative fungicide efficacy (Figure 2). Categories 1–8 were previously used and the 'alternative fungicides' (category 0.1) is new. The re-application interval algorithm and parameter values have been changed, as outlined below.

			Single-site inhibitors				Single-site combinations		
Fungicide efficacy category Identifier	Alternative fungicides 0.1	Multi-site inhibitors 1	Group 7 SDHI 2	Group 11 QoI 3	Group 3 DMI 4	Multi-site + single-site 5	Groups 7 SDHI + 11 QoI 6	Groups 3 DMI + 11 SDHI 7	Groups 3 DMI + 11 QoI 8
R	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6
MIN	4.1	7.9	9.7	10.9	11.8	12.6	13.3	13.9	14.5
MAX	19.9	35.3	41.9	46.3	49.8	52.6	55.0	57.2	59.1

Figure 2. Parameter values for exponential decay curves for nine categories of fungicide efficacy. *R* = rate; *MIN* = minimum re-application interval (days); *MAX* = maximum re-application interval (days). *MIN* and *MAX* vary with fungicide efficacy category.

5 Accumulating weather risk and re-application interval

5.1 Revised algorithm for re-application interval

This update uses the same exponential decay function for calculating re-application interval from climatic risk as used previously:

Y = *MIN* + (1 / EXP(R * *X*) * (*MAX* - *MIN*)),

Where, *Y* = re-application interval (days),
X = 14-day accumulated overall risk
R = rate parameter with a value of 3.6,
MIN = minimum re-application interval,
MAX = maximum re-application interval.

Values for parameters *MIN* and *MAX* vary with the fungicide efficacy category. The method for calculating *MIN* and *MAX* is changed in this update because new field trial data show that the previous method gave differences in re-application interval between efficacy categories that were too small.

The new calculation method for *MIN* and *MAX* uses a power function as follows:

MIN = 7.9408 * *CAT*^0.2886,
MAX = 35.251 * *CAT*^0.2486,

Where, CAT = fungicide category identifier (0.1, 1, 2, 3, 4, 5, 6, 7, 8).

Therefore, for any given values of X (14 day accumulating overall risk) and CAT (fungicide category identifier), the value of Y (re-application interval) is as follows:

Y = (7.9408**CAT*^0.2886) + (1 / EXP(3.6 * *X*) * ((35.251 * *CAT*^0.2486) - (7.9408**CAT*^0.2886))).

Re-application interval curves for all fungicide efficacy categories over a range of 14-day accumulating overall risk values are shown in Figure 3.

Development of the re-application interval function, as described here, used historical data to calculate 14-day accumulated overall risk values. However, in implementing the algorithm online, 14-day cumulative overall risk should be calculated from forecast weather data so it is relevant to the future date when the next the spray is due.

Re-applic. Int. = (7.9408 * *CAT*^0.2886) + (1/EXP (3.6 * 14-d cum. OA risk) * (35.251 * *CAT*^0.2486) - (7.9408 * *CAT*^0.2886)))

where, *CAT* = fungicide category (0.1 – 8)

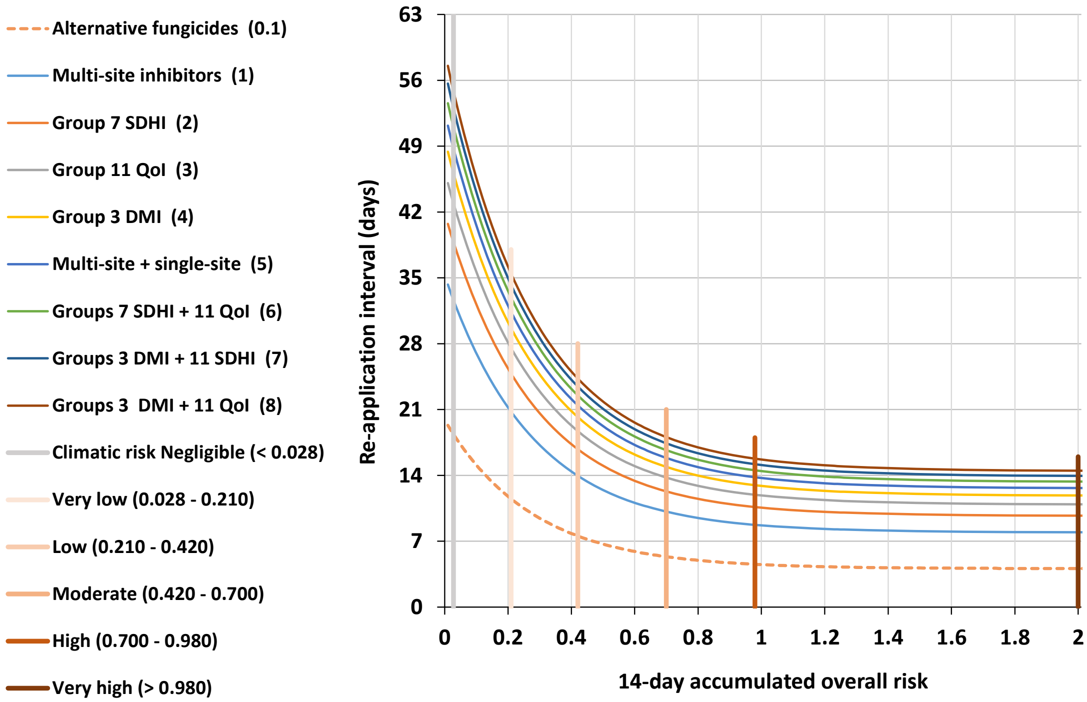


Figure 3. Exponential decay curves for nine fungicide efficacy categories, including alternative fungicides, multisite inhibitors and single-site inhibitors, in relation to increasing climatic risk. Six climatic risk categories calculated from 14-day accumulated overall risk, are indicated on the x-axis for reference (Appendix 3 and Appendix 4).

Figure 4 shows an example of predicted re-application intervals throughout a year calculated for a multisite inhibitor fungicide (efficacy category 1 in Figure 3). These are for Kerikeri (Northland) and Riwaka (Tasman) in a low-risk year (2017–2018) and a high-risk year (2019–2020).

Predicted re-application intervals are longer for Riwaka than Kerikeri because cooler temperatures result in lower overall accumulated risk values. Re-application interval is also more variable for Riwaka because temperatures fluctuate around the critical range where low temperature inhibits myrtle rust activity. In Kerikeri, by contrast, temperatures are more often above that range, so re-application intervals vary less, particularly in summer.

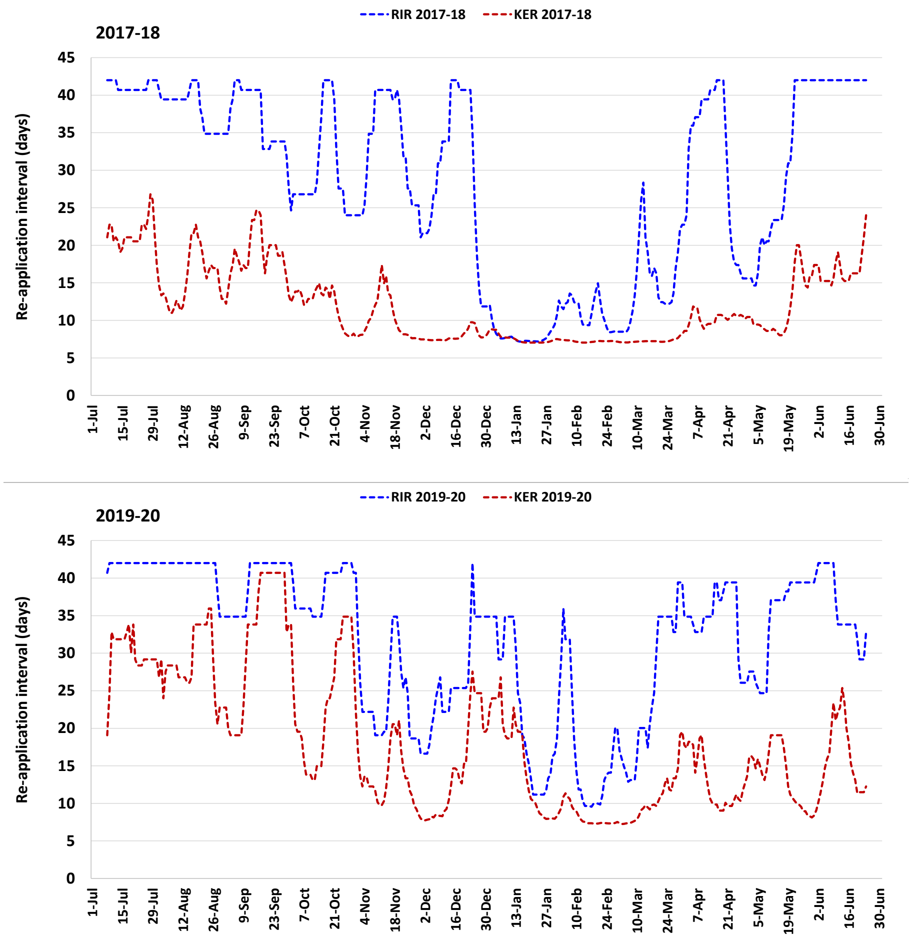


Figure 4. Day-to-day changes in 14-day cumulative overall risk for two sites (RIR = Riwaka, Motueka; KER = Kerikeri, Northland) in 2017–18 (top), a warm, high risk year, and in 2019–20 (bottom), a cooler lower risk year.

5.2 New concept of percentage fungicide protection

A new concept is proposed for inclusion in the accumulating risk display to allow users to track the degree of protection provided by the sprays that have been applied through the season. This is the ‘percentage of total risk protected by fungicide’ calculated as follows:

% fungicide protection = A / B * 100,

Where, A = sum of overall daily risk for the days with fungicide protection (blue dashed line in Figure 1),
B = total overall daily risk for the entire period (solid black + blue dashed lines).

The period over which % fungicide protection it is calculated could be between the ‘Start Date’ and ‘Stop Date’ (Figure 1), or, alternatively, for the period from ‘Exposure Date’ to ‘Stop Date’ to indicate season-long risk protection. Both of these would be useful and further discussion is required with HortPlus to finalise how best to present them in the online tool.

5.3 ‘Interpret risk’ update

The ‘Interpret Risk’ screen explains the different features of the online display for users. The current screen (Figure 5) needs to be updated to include the additional functionality of the accumulating risk model. The following updated content is suggested:

Overall Risk

The myrtle rust risk accumulation, called **Overall Risk**, is made up of the daily 'Infection Risk' and the 'Latent Period'.

Infection Risk: Likelihood that live spores deposited on a vulnerable host plant will germinate and infect.

Latent Period: Time from infection by spores to new spore-producing pustules.

Overall Risk reflects both weather suitable for infection and rate of disease development. Predicted risk applies to myrtle species that are vulnerable to myrtle rust in areas where infection is likely.

Exposure Date

When vulnerable plants are first exposed to myrtle rust in the environment (e.g., moved outdoors into an open growing area, or stock brought in from another site). Default value is 1 July.

Action Threshold

Orange horizontal lines show approximately when a fungicide spray is needed based only on climatic risk (overall risk accumulation). As the accumulation slows down, the time between fungicides increases, and when the accumulation increases the time shortens. Use **Add Spray** for actual fungicide applications and to generate exact information on when to re-apply the next fungicide.

Spray applications

Added spray applications will show on the graph. The accumulating risk is a solid black line when there is no fungicide protection. It turns to a blue dashed line when a spray is added and shows how long plants are protected from infection.

When a spray is added, the Action Threshold lines adjust to show when the next spray is due. The protected period is calculated from fungicide efficacy and climatic risk (based on recent research). It is also affected by wash-off from high rainfall.

% Protection: The percentage of total accumulating risk that is protected by fungicide.

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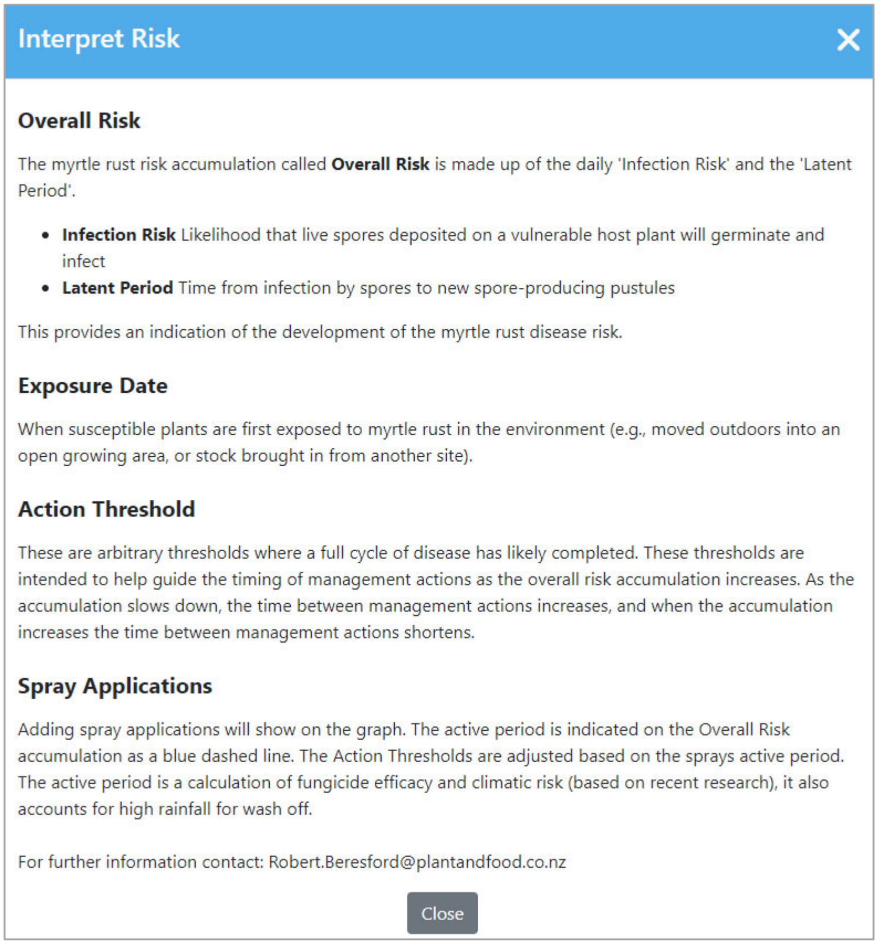

Figure 5. Current ‘Interpret Risk’ page in the online weather risk tool.

6 Discussion

The accuracy and utility of the initial spray interval algorithm was evaluated in two myrtle rust fungicide field trials in *Lophomyrtus* 'Red Dragon' at PFR Pukekohe between November 2022 and April 2023. The trials investigated single-site inhibitor, multisite-inhibitor and alternative fungicides (Appendix 1) and were of similar design to trials done the previous year (Beresford & Wright 2022).

Examination of the performance of the initial spray interval algorithm in relation to both years of trial data showed that the differences in re-application interval between fungicide efficacy categories did not accurately reflect the magnitude of differences between the different types of fungicide. Therefore, the efficacy category parameters (Figure 2) and algorithm ('Accumulating weather risk and re-application interval section') have been updated in this report to correct that problem.

This upgrade also introduces the new index for 'percentage fungicide protection' that will allow users of the weather risk tool to track the degree of protection provided by sprays they have been applying through the season. Details of how this index is displayed in the upgraded tool are currently being worked through with HortPlus Ltd.

The re-application interval required for effective myrtle rust protection depends on five factors:

1. Climatic risk of disease
2. Fungicide product efficacy
3. Fungicide deposit weathering (particularly high rainfall events)
4. Emergence of new unprotected host plant tissue
5. Risk of nearby sources of infection

Numbers 1–3 are now effectively addressed after this upgrade of the weather risk tool and work to address Number 4 is currently being discussed with NZPPI. Number 5, which is actually crucial in determining risk of myrtle rust infection in nurseries, as well as in the natural estate, is not currently considered. This is because new technology would be required to quantify and monitor airborne spore numbers and no funding stream is able to be identified at present to develop this.

7 Acknowledgements

NZPPI for funding development of the online weather risk tool and HortPlus for constructive collaboration in developing and updating the risk algorithm for the online weather-risk tool.

8 References

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Appendix 1. NZPPI suggested fungicides

NZPPI fungicide list for myrtle rust (December 2021) (Download.aspx (nzppi.co.nz)).

Table 1 Suggested Fungicides for Control of Myrtle Rust

DO NOT APPLY FUNGICIDES TO PLANTS IN FLOWER.

Product Name	Active Ingredient*	Type of Activity	Mode of Action Group***	Minimum Interval Between Applications (days)
Cereous + 6 other brands	250 g/l triadimenol	Systemic, curative, protectant	3	14-21
Tilt® + 4 other brands	250 g/l propiconazole	Systemic, curative, protectant	3	7
Scorpio®	200 g/l tebuconazole + 100 g/l trifloxystrobin	Systemic, curative, protectant	3/11	14
Dithane™ Rainshield ™ Neo Tec™ + 15 other brands	750 g/kg mancozeb	Non-systemic protectant	M3	7
Amistar® + 13 other brands	250 g/l azoxystrobin	Systemic, translaminar, protectant	11	14-21
Kocide® Opti™ + 8 other brands	300 g/kg copper hydroxide	Non-systemic protectant	M1	7-14
Bravo® Weatherstick + 13 other brands	720 g/l chlorothalonil	Non-systemic protectant	M5	7-14
Elatus® Plus	100 g/l benzovindiflupyr	Xylem systemic, translaminar, protectant	7	14-21
Sercadis®	300 g/l fluxapyroxad	Xylem systemic, translaminar, protectant	7	14-21
Opus + 13 other brands	Epoxiconazole	Systemic, curative, protectant	3	14-21 days

*Active ingredient concentration stated for the brand name product only. Active ingredient content of other products may differ from brand name products and thus rate of application may need to be adjusted. ** See product label for Certified Handler / Qualified Person requirements. ***From the NZCPR website (www.nzpps.org/resistance/index.php). Dithane™ Rainshield™Neo Tec™ are trademarks of The Dow Chemical Company ("Dow") or an affiliated company of Dow. Elatus™ Plus is a trademark of a Syngenta Group Company. Kocide® is a registered trademark of Kocide LLC. Tilt®, Amistar®, Bravo® are registered trademarks of a Syngenta Group Company. Sercadis® is a registered trademark of BASF. Scorpio® is a registered trademark of the Bayer Group.

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Appendix 2. Efficacy of myrtle rust fungicides

The table below was compiled from field trial information on fungicide control of myrtle rust from recent New Zealand research (Beresford & Wright 2022, Beresford unpublished) and data published internationally, as summarised by Chng et al (2019). Below the table are comments on fungicide mixtures and a glossary of terms relevant to myrtle rust fungicides, their modes of action, efficacy and the development of fungicide resistance.

[1]Fungicide active ingredient	Mode of action group	[2]Relative myrtle rust efficacy	Comments
Single-site inhibitors			
Cyproconazole	Group 3 DMI	+++	Only reported use is in mixture with Group 11 fungicides
Difenoconazole	"	+++	
Epoxiconazole	"	+++	Only reported use is in mixture with Group 11 fungicides
Flusilazole	"	+++	
Myclobutanil	"	+++	Good curative but limited protective activity
Propiconazole	"	+++	
Prothioconazole	"	+++	
Tebuconazole	"	+++	
Tetraconazole	"	+++	
Triadimenol	"	++++	Consistently reported as having best myrtle rust efficacy
Triforine	"	+++	Variable performance reported
Azoxystrobin	Group 11 QoI	+++	
Pyraclostrobin	"	+++	
Trifloxystrobiin	"	+++	
Benzovindiflupyr	Group 7 SDHI	++	Good protective activity but poor curative activity
Fluopyram	"	++	"
Fluxapyroxad	"	++	"
Isopyrazam	"	++	"
Penthiopyrad	"	++	
Pydiflumetofen	"	++	
Mixtures containing any two of Group 3, Group 7 and Group 11 fungicides		++++	
Multi-site inhibitors			
Copper hydroxide	M1	+	Variable performance reported
Copper oxide	"	+	"
Copper oxychloride	"	+	"
Mancozeb	M3	+	"
Chlorothalonil	M5	+	"
Multi-site and single-site mixtures		+++	
Alternative fungicides			
Sodium bicarbonate	Not classified	**0**	Poor efficacy: not effective when disease risk is high
Potassium bicarbonate	"	**0**	"

[1]From frac-code-list-2022--final.pdf.
[2]Relative efficacy: 0 = very low; + = low; ++ = Moderate; +++ = High; ++++ = Very 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 a fungicide with efficacy together 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 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).

Alternative fungicides: Chemical compounds containing relatively benign active ingredients that are generally regarded as less harmful in relation to environmental and human toxicology compared with conventional plant protection chemicals. They tend to have relatively low efficacy against the plant pathogens they target.

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 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 disease 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.

Appendix 3. Regional and seasonal climatic risk

Figure 15 from Beresford et al. (2022).

Myrtle rust risk is higher in the upper North Island and lower in the South Island and in higher altitude areas. It tends to be slightly greater in western areas than eastern areas of both the North and South Islands. Regional and seasonal trends in climatic risk, as they determine the need for fungicide protection, are shown below.

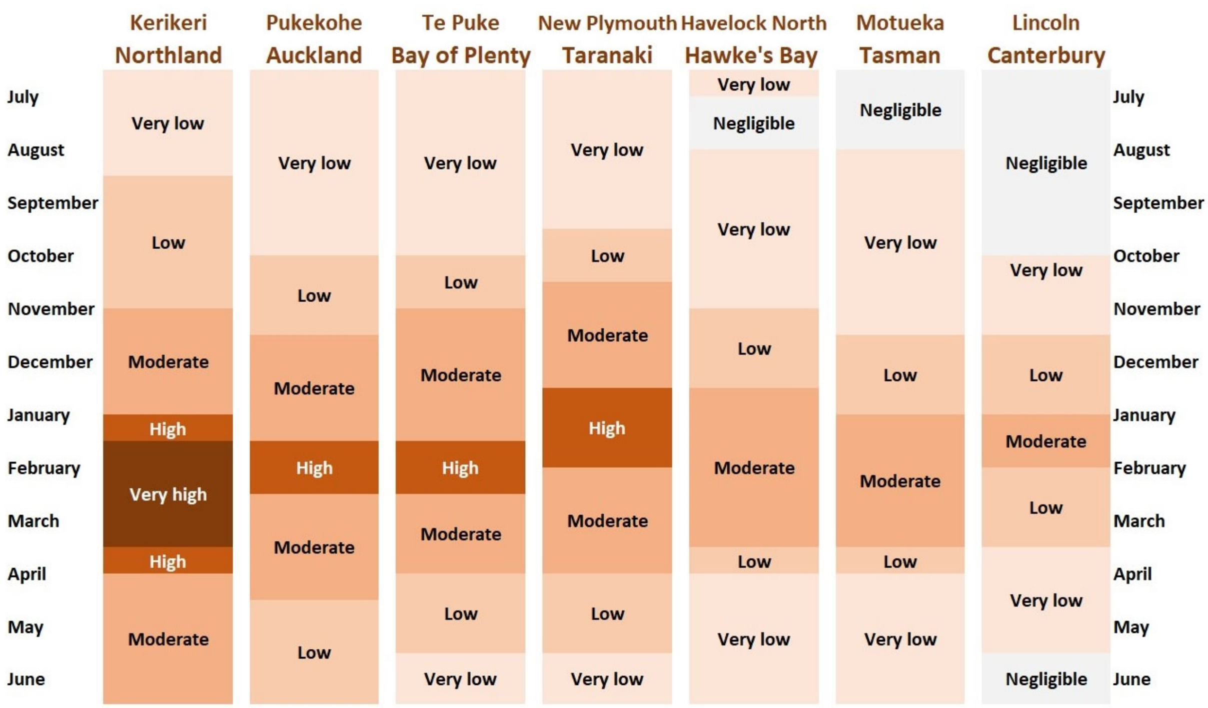


Figure 15. Summary of average myrtle rust climatic risk over 6 years (2016–22) at selected locations in seven New Zealand regions as it affects the need for nursery fungicide spraying to protect highly vulnerable myrtle species. Information based on daily overall risk calculations for each location, where negligible = 0–0.002; Very low = 0.0020–0.015; Low = 0.015–0.03; Moderate = 0.03–0.05; High = 0.05–0.07; Very high = >0.07.

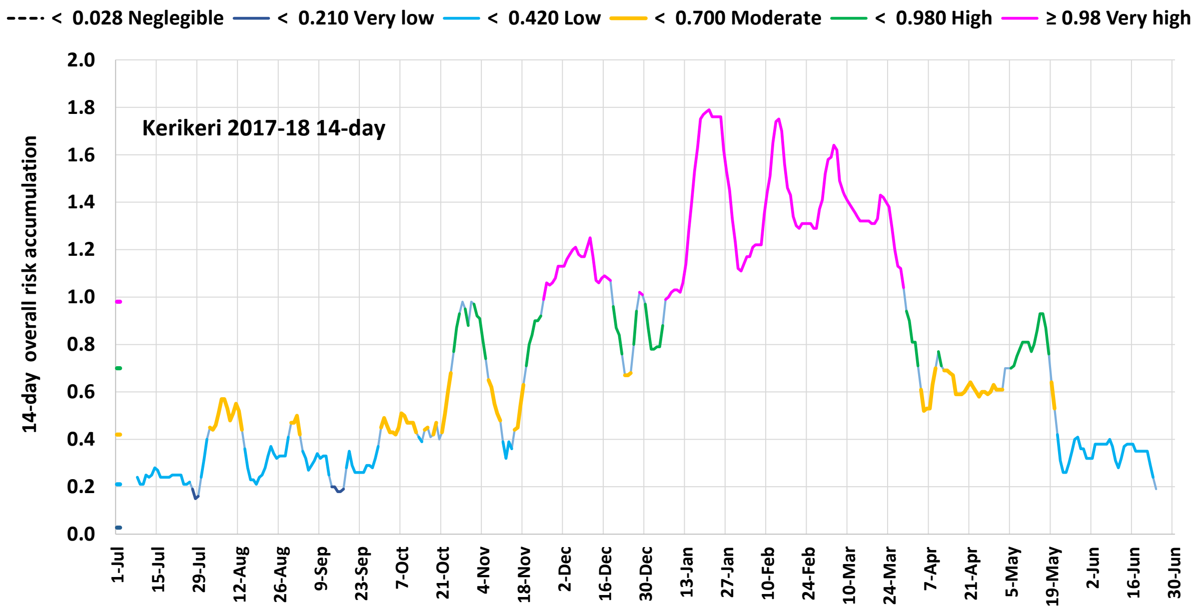
Appendix 4. Criteria for climatic risk categories

The regional and seasonal climatic risk categories in Appendix 3 are determined from the 14-day accumulation of overall risk as follows:

- The cumulative daily overall risk index was summed over the previous 14 days throughout the year (1 July – 30 June).
- The cumulative overall risk for each 14-day day period was allocated to one of six risk categories, which relate to the climatic risk categories in Appendix 3, as follows:

    1. 0.00 < Negligible ≤ 0.028
    2. 0.028 < Very low ≤ 0.210
    3. 0.210 < Low ≤ 0.420
    4. 0.420 < Moderate ≤ 0.700
    5. 0.700 < High ≤ 0.980
    6. 0.980 < Very high

Seasonal patterns of 14-day cumulative daily overall risk in the above risk categories are shown below for two climatically contrasted regions: Kerikeri in Northland and Riwaka (near Motueka) in Tasman. Figure A4.1 shows 2017–18, which was a year with an extreme marine heatwave event (Special Climate Statement 2017-18 Summer | NIWA) and Figure A4.2 shows 2019–20, which was one of the lowest risk years since myrtle rust was first detected in New Zealand in 2017.



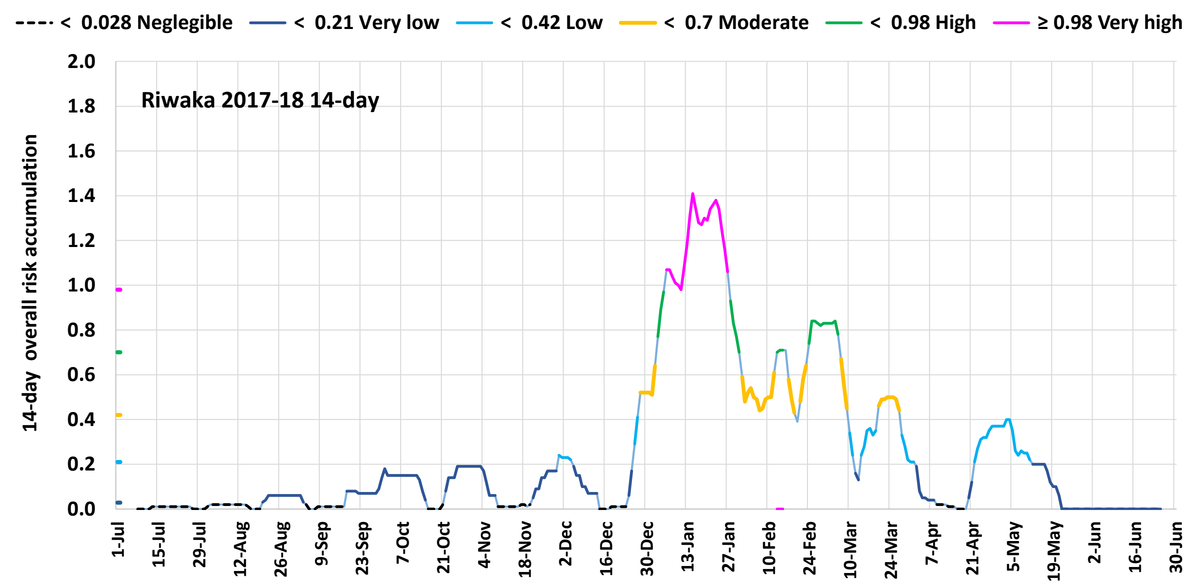
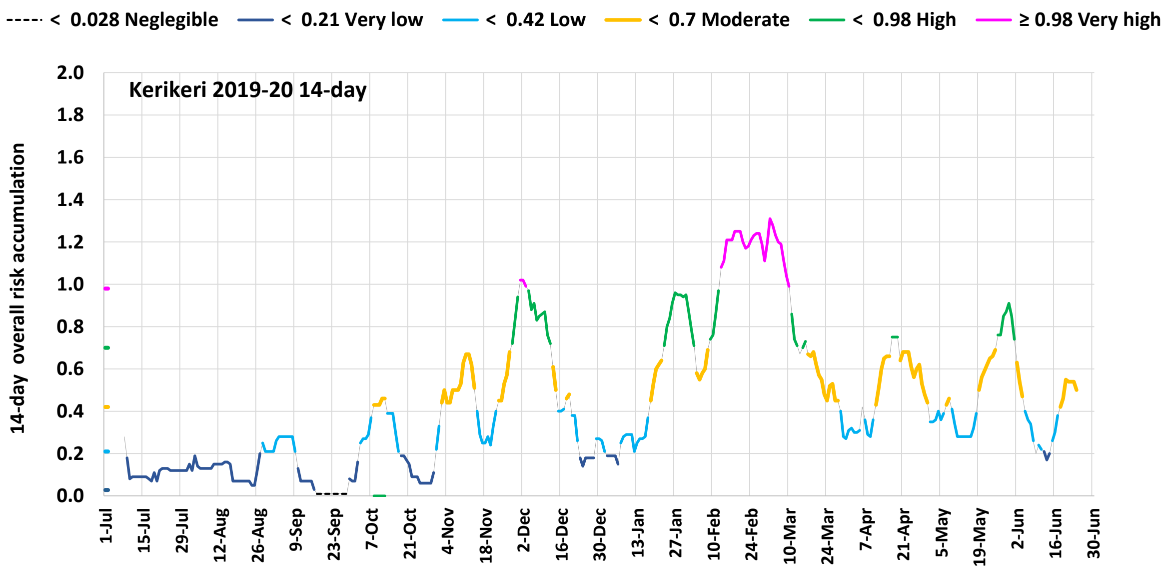


Figure A 4.1. Comparison of 14-day accumulated overall risk in six categories for Riwaka and Kerikeri in the marine heatwave season of 2017–18, which had particularly high myrtle rust risk.



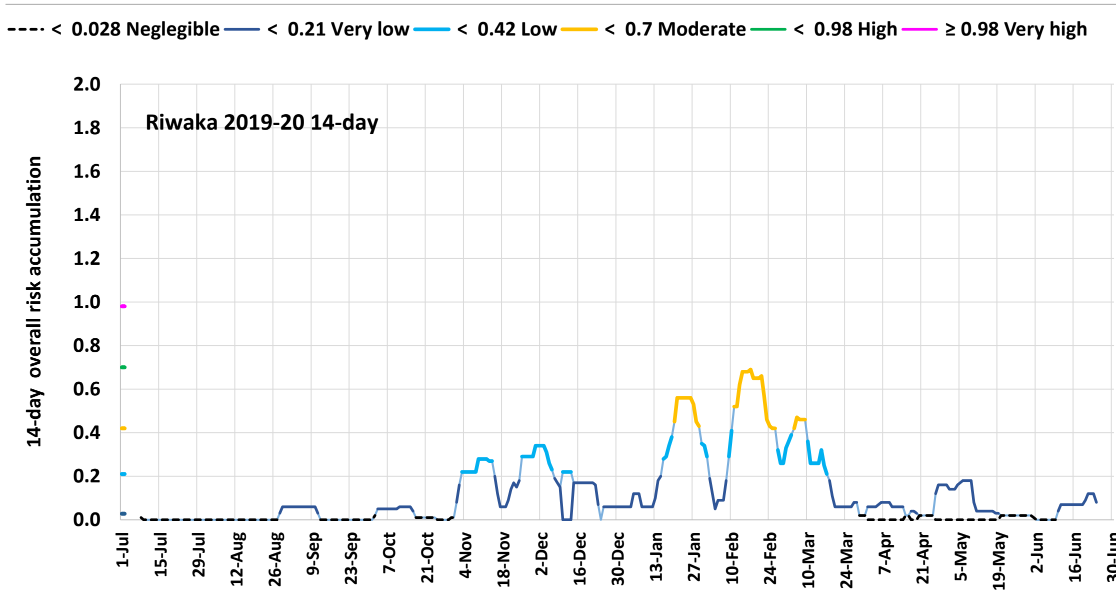


Figure A 4.2. Comparison of 14-day accumulated overall risk in six categories for Riwaka and Kerikeri in the 2019–20 season, which had particularly low myrtle rust risk.

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